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TWO NEW BACTERIAL DISEASES OF PLANTS

M. K. PATEL, Y. S. KULKARNI & G. W. DHANDE

(Accepted for publication, April 7, 1954)

In this paper it is proposed to give an extended account of a short note by the authors[1] on two new bacterial diseases on *Clerodendron phlomoides*, Linn. and *Sesbania aegyptiaca*, Pers.

1. Bacterial leaf-spot of *Clerodendron phlomoides.*

C. phlomoides, locally known as "*Arni*" is a tall pubescent shrub, common in many parts of India, principally in the drier regions of the Punjab, Sind, Marwar, the Deccan, Bihar, Bengal, Oudh, Madhya Pradesh, Gujarat and also in Ceylon. It is used in medicine as a bitter tonic and is given in convalescence after measles. The juice of leaves is considered by the Indian practioners as alterative. Besides its use as a medicine, its leaves are relished by cattle, especially the goats. A bacterial leaf-spot on this plant was noticed for the first time near Kirkee (Poona) in 1949, since when it has been seen along the railroads and in hedges in several places in Bombay State.

SYMPTOMS

Intensity of the disease is so severe that leaf-spots are visible from a distance during the rainy season. In the initial stage, the pathogen produces round, minute, water-soaked spots on the lower surface of leaves. In advanced stages of infection, the spots become irregular in shape and often coalesce to form large, angular lesions measuring 4 mm. (Plate I, fig. 1). The corresponding areas on the upper surface of leaves become brown to dark brown. Often the spots have a thin parched centre and at times cause slight leaf crinkling and cracking. Bacterial ooze in the form of small pearly beads appears on the lower surface of leaves. The pathogen is able to infect veins and leaf edges also, although infection on petiole or stem had not been seen. The incubation period varies from 4 to 7 days.

MORPHOLOGY

The pathogen, which can be easily isolated by the usual poured plate method, is a short rod, mostly single, rarely in chains of two and with no involution forms. It measures $1.1 \times 0.5\mu$. It is motile by a polar flagellum, gram negative, non-spore former, capsulated and not acid fast. It can readily be stained with common dyes.

CULTURAL AND PHYSIOLOGICAL CHARACTERS

On potato dextrose agar plates, colonies are circular with entire margins, measuring 1.8 cm. in diameter after 7 days; colour pale lemon

1. Patel, M.K., Y.S. Kulkarni and G.W. Dhande (1952) *Current Science* : **21**, 74-75.

yellow (R)* ; on nutrient agar plates growth poor, flat, measuring 0.8 cm. after 4 days, colour straw yellow (R) ; on nutrient dextrose agar plates colonies are circular with no striations, convex with entire margin; measure 1.3 cm. in diameter after 4 days, colour Pinard yellow (R) ; on potato cylinders growth copious, raised, shining, flowing, covering the entire surface in about 4 days, colour Colonial buff (R) ; colour of the cylinder not changed.

The organism liquefies gelatin and digests starch and casein ; litmus reduced ; nitrate not reduced to nitrite ; ammonia and hydrogen sulphide produced ; M.R. and V.P. tests negative ; Loeffler's blood serum slowly liquefied in 7 days ; sodium chloride tolerant upto 2 per cent. Thermal death point is about 51°C.

The organism grows well in several synthetic media separately containing 1 per cent dextrose, sucrose, lactose, galactose, levulose, glycerol, dextrin and maltose with the production of acid but no gas. It fails to ferment salicin and acetic, oxalic and tartaric acids. Grows well in citric acid.

Host Range

It infects only *C. phlomoides*, but not *Pisum sativum* L., *Medicago sativa* L., *Vigna catjang* Walp., *Xanthium strumarium* L., *Cicer arietinum* L., *Ricinus communis* L., *Citrus sinensis* Osbeck., *Cajanus cajan* Millsp., *Sesbania aegyptiaca* Pers., *Ipomoea muricata* R and Sch., *Cyamopsis tetragonoloba* Taub., *Solanum melongena* L., *Desmodium diffusum* DC., *Cassia tora* L., *Lathyrus sativus* L.. *Trigonella phoenum-graecum.*, *Stizolobium deeringianum* Bort., *Arachis hypogaea* L., *Desmodium gangeticum*, *Triticum sativum*, *Clerodendron inermis*, *Clerodendron infortunatum*, *Lantana alba*, *Duranta plumieri*. *Tectona grandis*, and *Vitex negundo*.

Taxonomy and Nomenclature

Since the organism under study is a typical Xanthomonad and new to science, it is proposed to name it *Xanthomonas clerodendroni* nov. sp.

Technical Description

Xanthomonas clerodendroni Patel, Kulkarni & Dhande sp. nov., short rods, mostly single, rarely in chains, measuring 1.1 to 0.5μ, motile by a polar flagellum, gram negative, non-spore former, capsulated, not acid fast, aerobe, stains readily with common dyes ; copious growth on potato cylinders and potato dextrose agar slants ; on nutrient dextrose agar plates colonies are circular without striations and of straw yellow colour ; acid but no gas from dextrose, lactose, maltose ; no growth in salicin and acetic, oxalic and tartaric acids, good growth in citric acid ; gelatin liquefied, starch and casein hydrolysed, litmus reduced, nitrite not produced from nitrate ; ammonia and hydrogen sulphide produced; indol and M.R. and V.P. tests negative ; Loeffler's blood serum slowly

*Ridgway's colour standard is followed.

liquefied ; sodium chloride tolerant upto 2 per cent ; optimum temperature for growth between 25° and 30°C., thermal death point 51°C.

Pathogenic on *Clerodendron phlomoides* producing leaf-spots and crinkling of leaf. Found at several places in Bombay State.

2. Bacterial leaf-spot of *Shevri* (*Sesbania aegyptiaca* Pers.)

Shevri, a soft wooded shrub of short duration, is grown throughout India besides Ceylon and Siam. In the Deccan, it is used as poles to substitute bamboo and is often utilised to shade and support the *Piper* vines and various cucurbitaceous plants. The wood is employed to boil jaggery and is reduced to charcoal for use in gunpowder. In Assam, mats are prepared from it, while in Bengal, it is commonly used as a hedge plant. Seeds are used as astringent, stimulant to check diarrhoea, to reduce the enlargement of the spleen and in ointment for itches. The root, well-bruised and made into a paste, is an excellent antidote against scorpion sting. The leaves and young branches are lopped for fodder.

A bacterial leaf-spot was noticed on leaves of this plant in 1949 on the Agricultural College Farms, Poona and Dharwar.

SYMPTOMS

On the leaves the disease appears as small, round, water-soaked spots measuring 0.3 to 9.5 mm., which often enlarge in size (2 mm.) (Plate I, fig. 2) and are usually surrounded by a halo measuring 1.5 to 2 mm. The corresponding areas on the upper surface become chlorotic and later become brown while the surrounding area turns yellow. As a result of severe infection, the entire leaflet becomes chlorotic and ultimately sheds. On the rachis of the leaf, infection takes place in the form of long verticle grayish lesions upto 3 mm. in length. The centre of such lesions often cracks, oozing minute, pearly bacterial gummy beads. Infection of the tender stem is found in the form of vertical grayish streaks measuring about 4 mm. The pathogen infects leaf-edges also.

MORPHOLOGY

The pathogen is a short rod with rounded ends, mostly single or rarely in chains of 2 with no involution forms. The organism from a week-old culture on potato dextrose agar measures $1.3 \times 0.7\mu$. It is motile by a polar flagellum, gram negative, non-spore former, capsulated and not acid fast. It stains readily with common dyes.

CULTURAL AND PHYSIOLOGICAL CHARACTERS

In nutrient agar plates, growth is poor, flat and colonies measure 1.2 cm. in 4 days ; colour lemon crome (R) ; on nutrient dextrose agar plates colonies are round with entire margins, convex, 1.2 cm. in 4 days, colour lemon yellow (R). In potato dextrose agar plates colonies are round, 2 cms. in diameter after 4 days, striations starting 5 mm. away from the centre coming upto the periphery, colour Barium yellow (R).

The organism liquefies gelatin and is able to digest starch and casein, reduces litmus, not reducing nitrates to nitrites ; ammonia and hydrogen sulphide produced ; M.R. and V.P. tests negative ; Loeffler's blood serum is slowly liquefied in 7 days ; sodium chloride tolerant upto 2 per cent. Thermal death point is about 51°C.

The organism grows well with the production of acid but no gas on several synthetic carbohydrate media containing separately one per cent dextrose, lactose and maltose. It fails to grow in salicin and acetic, oxalic and tartaric acids, but grows well in citric acid.

Host Range

Several attempts to infect *Pisum sativum* L., *Medicago sativa* L., *Brassica oleracea* L., *Lycopersicum esculentum* Mill., *Crotolaria juncea* L., *Vigna catjang* Walp., *Desmodium diffusum* DC., *Arachis hypogaea* L., *Stizolobium deeringianum* Bort., *Trigonella phoenum-graecum*, *Lathyrus sativus* L., *Cassia tora* L., *Solanum melongena* L., *Cyamopsis tetragonoloba* Taub. *Ipomea muricata* R. and Sch., *Cajanus cajan* Millsp., *Citrus sinensis* Osbeck., *Ricinus communis* L., *Zea mays* L., *Cicer arietinum* L., *Xanthium strumarium* L., *Triticum sativum* L., *Capsicum annuum*, *Begonia* sp. and *Sesbania grandiflora* Pers. failed. *S. aegyptiaca* got infected quite successfully every time.

Taxonomy and Nomenclature

Since the pathogen under study is new to science and tallies in important morphological, cultural and physiological reactions given by Dowson[2] under the genus *Xanthomonas*, it is proposed to name it *Xanthomonas sesbaniae* nov. sp.

Technical Description

Xanthomonas sesbaniae Patel, Kulkarni and Dhande sp. nov. short rods ; mostly single or rarely in chains measuring $1.3 \times 0.7\mu$; motile by a polar flagellum, gram negative ; non-spore former, capsulated, not acid fast ; aerobe, stains readily with common dyes ; copious growth on potato cylinder and potato dextrose agar slants ; colonies on nutrient dextrose agar plates lemon yellow (R) ; acid but no gas from dextrose, lactose, maltose ; no growth in salicin and acetic, oxalic and tartaric acids ; good growth in citric acid ; gelatin liquefied ; starch and casein hydrolysed ; slight growth in Fermi's and Cohn's solution ; litmus reduced ; nitrite not produced from nitrate ; ammonia and hydrogen sulphide produced; indole, M.R. and V.P. tests negative; Loeffler's blood serum slowly liquefied ; sodium chloride tolerant upto 2 per cent ; fair growth in synthetic asparagin medium ; optimum temperature for growth between 25° and 30°C ; thermal death point 51°C.

Pathogenic on *Sesbania aegyptiaca* causing leaf-spot and in severe cases, shedding of leaflets. Found at several places in Bombay State.

2. Dowson, W. J. (1949). Manual of Bacterial plant diseases. Adam and Charles Black. 456, Soho square, London, W-1.

PLATE I

FIG. 1

FIG. 2

SUMMARY

Two new bacterial diseases caused by *Xanthomonas clerodendroni* and *X. sesbaniae* on *Clerodendren phlomoides* and *Sesbania aegytiaca* respectively are recorded for the first time.

The organisms are host specific.

Diseased specimens are deposited in the herbaria of the Plant Pathologist to Government, College of Agriculture, Poona 5; Indian Agricultural Reasearch Institute, New Delhi and the Commonwealth Mycological Institute, Kew, Surrey, England.

Plant Pathological Laboratory,
College of Agriculture,
Poona 5.

EXPLANATION OF PLATES

PLATE I

Fig. 1. Leaves of *Clerodendron phlomoides* showing round to irregular, minute, water-soaked spots often coalescing. Leaf edges and veins are also seen infected.

Fig. 2. Leaves of *Sesbania aegyptiaca* showing small, round, water-soaked spots surrounded by halo.

FRUIT ROT OF NUTMEG

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(Accepted for publication, June 12, 1954)

Nutmeg (*Myristica fragrans* Houll) is grown on the lower elevations of Nilgiris and in some portions of Western Ghats (Kuttalam). It is cultivated for the sake of the spice nutmeg and mace obtained from the seed and the aril respectively. The fruit when ripe is globular or pear shaped with a pale orange colour and a groove running down one side. It is about two to two and a half inches in length and one and a half to two and a half inches across. When quite ripe the fleshy pericarp splits open along the groove exposing the branched bright red aril covering the seed. The seed and the mace are of commercial importance while the pericarp is locally used for pickling.

In 1953, a disease affecting nutmeg fruits was observed during the monsoon months (August to October) in a garden at Burliar situated at about 2500 feet above sea level (Nilgiris). The incidence was confined to fruits which were half mature while the tender ones were quite free. The affected fruits exhibited rotting and disintegration of the rind near the stalk end or involving the entire fruit. The tissues were watersoaked and varied in colour from dull green to dark brown. The pericarp was prematurely split and several of the fruits had dropped. The infection in some cases spread to the mace and the seed which rotted and became enveloped by copious growth of greyish mycelium. Meanwhile pycnidia of *Diplodia* had formed singly or in groups on the surface of the rind.

They were erumpent, globose, gregarious or sparse and black coloured. In a few cases papillae were evident. The pycnidia were usually embedded, one to three in a stroma. They measured 163μ in height and 340μ in breadth being broader than high. The pycnidiospores in young pycnidia were hyaline and one-celled, while those in mature pycnidia were oblong or elliptical, not constricted at the septum, dark brown and 2-celled with longitudinal striations on the wall. They measured $22 \times 13\mu$ $(20-30 \times 11-18)$. On a number of affected fruits numerous erumpent acervuli covered by pinkish masses of spores were also present and these were identified as belonging to *Gloeosporium* sp. The acervuli lacked any evidence of setae. The conidia were oblong, hyaline, one-celled with rounded ends and measured $15 \times 5\mu$ $(12-19 \times 4-5)$. Pure cultures of these two fungi were isolated from single spores and were used in further investigations.

Diseases affecting the fruits of nutmeg have been recorded from the East and West Indies. An internal decay of nutmeg seeds caused by a fungus closely resembling *Phomopsis citri* Faw. has been described by Ashby (1922) from Grenada. Leefmans (1926) has reported severe damage of nutmeg fruits in Java caused by an undetermined fungus. Later, a disease caused by *Coryneum myristicae* is recorded to have been responsible for severe damage of the fruits in Java rendering about

fifty per cent of crop unmarketable, the fruits bursting before ripening (Leefmans, 1934). Steinmann (1928) described a fruit rot of nutmeg from Java and ascribed it to infection by *Cercospora myristicae*. Internal mouldiness is stated to be common in Java in freshly cured nuts. *Aspergillus* sp. is recorded as the organism associated with this. Burst nuts or those damaged by beetles are also heavily contaminated (Slooff, 1949).

PATHOGENICITY TRIALS

On nutmeg: The pure cultures of the two organisms *Diplodia* sp. and *Gloeosporium* sp. were used for determining their pathogenicity on nutmeg. Inoculations were carried out on the fruits both tender and half mature on the trees at Burliar. The suspension of the spores was sprayed on washed healthy fruits. Wounds were made in one set of the fruits by means of sterilised needles while an equal number was left without wounding. Suitable controls were maintained. The fruits were enclosed in transparent alkathene bags. The following results were obtained.

TABLE I.

Results of inoculation on nutmeg fruits.

Condition of fruits when inoculated	*Diplodia*		*Gloeosporium*	
	Number inoculated	Number infected	Number inoculated	Number infected
Unwounded tender fruits.	6	...	6	...
Wounded tender fruits	6	...	6	...
Unwounded half mature fruits	10	10	6	...
Wounded half mature fruits	10	10	10	8

It is evident from the above results that *Diplodia* infects the half mature fruits of nutmeg whether the inoculations have been made on wounded or unwounded fruits. The symptoms of infection were evident in the course of 10 to 15 days and were similar to those observed in nature. In the case of the unwounded fruits partial rotting and splitting of the rind were observed. In the wounded series the rotting was more extensive and involved the entire fruit. In both cases the fruits had separated from the stalk and dropped into the bags. The fruits left as control were green and sticking firmly to the branches.

Gloeosporium infected only wounded, half mature fruits. The unwounded ones were not affected. Thus this fungus was found to be only a wound parasite. Both the fungi were unable to infect tender fruits. Further studies were confined to *Diplodia* as this was found to be the chief causal organism. The host range of the isolate and other characters were studied.

Other hosts : In order to determine the host range, inoculations were carried out with *Diplodia* on healthy fruits *in situ* on parent plants or on healthy plants grown in pots. Sweet potato tubers and groundnut pods were kept in moist chambers. The results obtained are given hereunder.

TABLE II

Results of inoculation on other hosts.

Host	Part inoculated	Wounded		Unwounded	
		Number ino-culated	Number infec-ted	Number ino-culated	Number infec-ted
Citrus sinensis	Young fruit	10	10	10	10
Ricinus communis	Young fruits	25	25	25	25
	Stem of young plants......	5	...	5	...
Gossypium hirsutum	Bolls	5	...	5	...
Allium cepa	Base of shoot	5	5	5	5
Benincasa hispida	Young fruit	5	...	5	...
Ipomaea batatas	Tubers	5	5	5	5
Arachis hypogea	Pods	10	10	10	10

Suitable controls were maintained and these remained healthy. The isolate was found to be pathogenic on orange and castor fruits, onion shoots, sweet potato tuber and groundnut pods. On orange, symptoms akin to those of 'stem-end rot' developed on the fruits in ten days. The lesions were extensive with brown margin and grey centre

and pycnidia developed on the infected area on the rind. Infected fruits attained premature yellow colour and were shed while the controls were green and firmly attached to the trees.

Young castor plants were not infected by the fungus. But the green capsules were easily invaded in six days. The fruits rotted and the panicle exhibited symptoms of dieback.

The aerial shoots of onion were killed and black pycnidia developed on the affected shoots. The inner fleshy scales were not involved but the thin outer ones were invaded. Dark brown water-soaked lesions developed on the inoculated tubers of sweet potato followed by rotting of the internal tissues. Pycnidia were formed on the surface of the affected portions. Groundnut pods were readily infected and profuse development of pycnidia was evident. The seeds were shrunk and enveloped in a mass of grey mycelial growth. The isolate was found to be pathogenic on a number of host plants affected by *D. natalensis* Evans.

THE FUNGAL CHARACTERS

The fungus was grown on different media and the growth characters recorded. There was copious growth on a number of media at the laboratory temperature (26° to 30° C) and pycnidia developed on the surface of the agar. The cultural characters are given below :—

TABLE III

Cultural characters

Medium	Diameter of growth on 4th day in cm.	Nature of submerged growth	Nature of aerial growth	Pycnidial formation
Oat agar	7.1	Dark olive grey in the centre, margin not coloured	Profuse, greyish white	Abundant
Maize meal agar	6.5	Dark olive grey	Scanty, olive grey	—do—
Potato dextrose agar	9.0	Dark olive grey	Profuse, light olive grey	—do—
Richards, agar	7.8	Brownish drab	Sparse, light brownish drab	Less of pycnidia
Brown's agar	6.1	Iron grey	Sparse, storm grey	No pycnidia

The best growth was obtained on potato dextrose agar while it was scanty on Brown's agar. Pycnidial development was evident after 10 days on all the media except Brown's agar. Stromatic masses began to develop on the surface of the growth in about 7 days and the pycnidia were formed in groups on these. Stevens and Wilcox (1925) have noticed similar development of stromatic masses and pycnidia in *D. natalensis.*

Varying statements have been made about pycnidiospore production of *D. natalensis* in culture media. Some authors could not get any pycnidia in cultures. Stevens and Wilcox (1925) had secured abundant pycnidiospore production in pure cultures, when these were kept in well ventilated green house in autumn and winter and in unheated wooden buildings in summer. They are of the opinion that high summer temperature does not permit the production of pycnidia. The isolate of *Diplodia* from nutmeg however freely developed abundant pycnidia under laboratory conditions without any special treatment. The room temperature in the laboratory varied between 26° and 30° C during the period.

It has been stated above that the pycnidial development was influenced by the medium used. In order to determine whether the quantity of the medium in the Petri dish had any influence on the formation of pycnidia, varying quantities of oat agar (on which profuse pycnidial formation had been observed) were poured into the dishes and these were inoculated with equal amounts of the culture of the fungus. The results are summarised below :

TABLE IV.

Pycnidial formation in relation to quantity of medium

Quantity of oat agar in c.c.	Depth of the medium in mm.	Frequency of pycnidial formation in 10 days.
15	3	0
25	5	+
35	7	++
45	9	+++
55	11	+++

0=no pycnidia ; +=few ; ++=medium +++=abundant

More pycnidia were formed in dishes having larger quantities of the medium.

Tisdale and West (in Tisdale 1934) found that the optimum temperature for the growth of *D. natalensis* and for the development of stem end rot of citrus in storage was between 26° and 29°C. Ramsey *et al* (1946) have observed that the isolate of *D. natalensis* from onion has 10°, 29.5° and 40°C. as the minimum, optimum, and maximum limits of temperature respectively. This fungus is reported to make some growth at 37°C. However cultures of *Diplodia* exhibiting variation in temperature relations have also been observed, and this has led to their being distinguished as 'high' and 'low temperature' forms. The growth of the isolate from nutmeg, on potato dextrose agar at different temperatures was recorded. The results were as follows.

TABLE V.

Growth measurements at different temperatures

Period	Diameter of the growth in mm. at						
	5°C.	15°C.	28°C.	30°C.	35°C.	37°C.	40°C.
3rd day	0	3	39	36	18	0	0
4th day	0	15	84	84	32	0	0

The maximum growth was obtained at 28° and 30°C. This isolate did not grow at 37°C. The medium developed a pale rose purple colour in the dishes kept at 35°C. Chromogenesis on potato dextrose agar is common in isolates of *D. natalensis* when kept at a temperature of 36°C.

The growth of the isolate on media containing different proportions of urea was studied. Oat agar was employed as the basic medium and to this 0.1, 0.5 and 1 per cent of urea were added. The growth characters are recorded below.

TABLE VI.

Growth of the fungus on media containing different proportions of urea

Proportion of urea	Diameter of growth on 3rd day in mm.	Colour of submerged growth and medium	Nature of aerial growth
Control	85	Iron grey	Olive grey, Profuse.
0.1%	42	Pale brownish drab.	Dark greenish olive, scanty.
0.5%	12	Congo Pink	Pallid grey, little growth.
1.0%	0	...	No growth.

Even 0.1 per cent of urea in the medium affects the growth of the fungus. Urea sprays are recommended for the control of dieback and dry root rot of citrus caused by *D. natalensis*. This disease is reported to be aggravated by nitrogen starvation. Urea besides being a source of nitrogen appears to have an inhibiting effect on the growth of *Diplodia*.

The size of the pycnidium in *Diplodia* is reported to vary with the host and the thickness of the bark on which it has grown. (Stevens and Wilcox, 1925). A comparision of the size of the pycnidia and the spores produced on different hosts was made and the measurements are given below :—

TABLE VII

Comparative measurements of pycnidia and pycnidiospores

Host	Pycnidia		Other characters	Pycnidiospores μ
	Height in μ	Breadth in μ		
Myristica fragrans	163—312	163—340	1—3 in a stroma	20—30×11—18 22×13
Citrus sinensis	177—448	136—326	1—6 in a stroma	20—28×11—16 24×13
Allium cepa	244—380	272—380	One in a stroma	20—28×12—14 23×13
Arachis hypogea	117—544	122—272	1—5 in a stroma	20—26×12—14 23×13
Ipomaea batatas	204—408	163—300	1—2 in a stroma	20—26×12—14 23×13

Wide variations are observed in the dimensions of the pycnidia on different hosts inocluated with the same culture of the isolate. However there is no difference in the size of the spores. The observations on the variability of the size of the pycindium made by earlier workers are borne out by these. This indicates that the size of the pycindium has no diagnostic value in the delimitation of species of *Diplodia* and is not be relied upon while the dimensions of the spores are more or less constant and are reliable.

Identity of the isolate : The measurements of the spores, the cultural characters and the range of pathogenicity indicate that this isolate is *D. natalensis*. This species has a very wide distribution and has been recorded on numerous host plants. Among the more important hosts are citrus, mango, avacado, mangosteen (fruits in storage), onion and cotton. The perfect stage of the fungus has been described as *Physalospora rhodina* (Berk. & Curt.) Cke. But this stage was not obtained either on the hosts examined locally or in culture.

Control: All the host plants (fruit trees) enumerated above are cultivated in the neighbourhood of Burliar and since the fungus can pass on from one to another the disease caused by this fungus is liable to spread unless preventive measures are undertaken. Stem-end rot and twig blight of citrus caused by this fungus is controlled by pruning of the affected twigs and spraying the trees with Bordeaux mixture. The same treatment is bound to be effective in controlling fruit rot of nutmeg also. The eradication of the sources of infection should be carefully attended to. Since the infection in nutmeg is prevalent only on half ripe fruits, the tender fruits may be protected with Bordeaux mixture and thus the incidence of the disease at a later stage prevented.

SUMMARY

A fruit rot of half ripe fruits of nutmeg was prevalent at Burliar. *Diplodia natalensis* was found to be mainly responsible for this. This fungus was also found to infect fruits of citrus and castor, pods of groundnut, tubers of sweet potato and aerial shoots of onion. Its cultural characters are described and control measures have been suggested. The intensity of pycnidial formation and the dimensions of the pycnidium are influenced by the medium and the host plant respectively.

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Agricultural College,
Coimbatore.

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Explanation of Plates

Plate I.

A. Fruits of nutmeg inoculated with *Diplodia* (unwounded). The controls are to the extreme left.

B. Fruit of nutmeg inoculated with *Diplodia* (wounded). Controls extreme left.

C. Fruits of nutmeg inoculated with *Gloeosporium* (unwounded). No effect.

D. Fruits of nutmeg inoculated with *Gloeosporium* (wounded). Controls extreme left.

Plate II.

A. Onion shoots infected by *Diplodia.* Control extreme left.

B. Orange fruits infected by *Diplodia.* Control top.

PLATE I

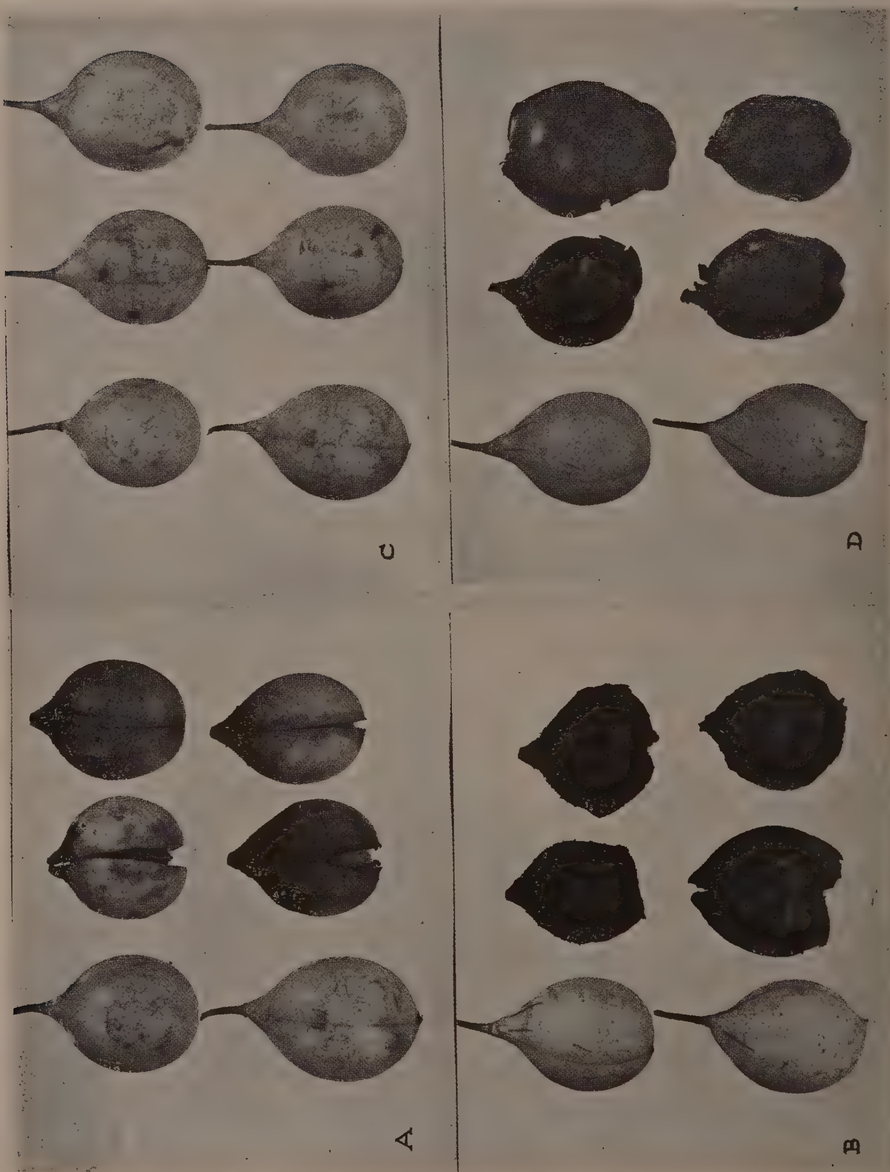
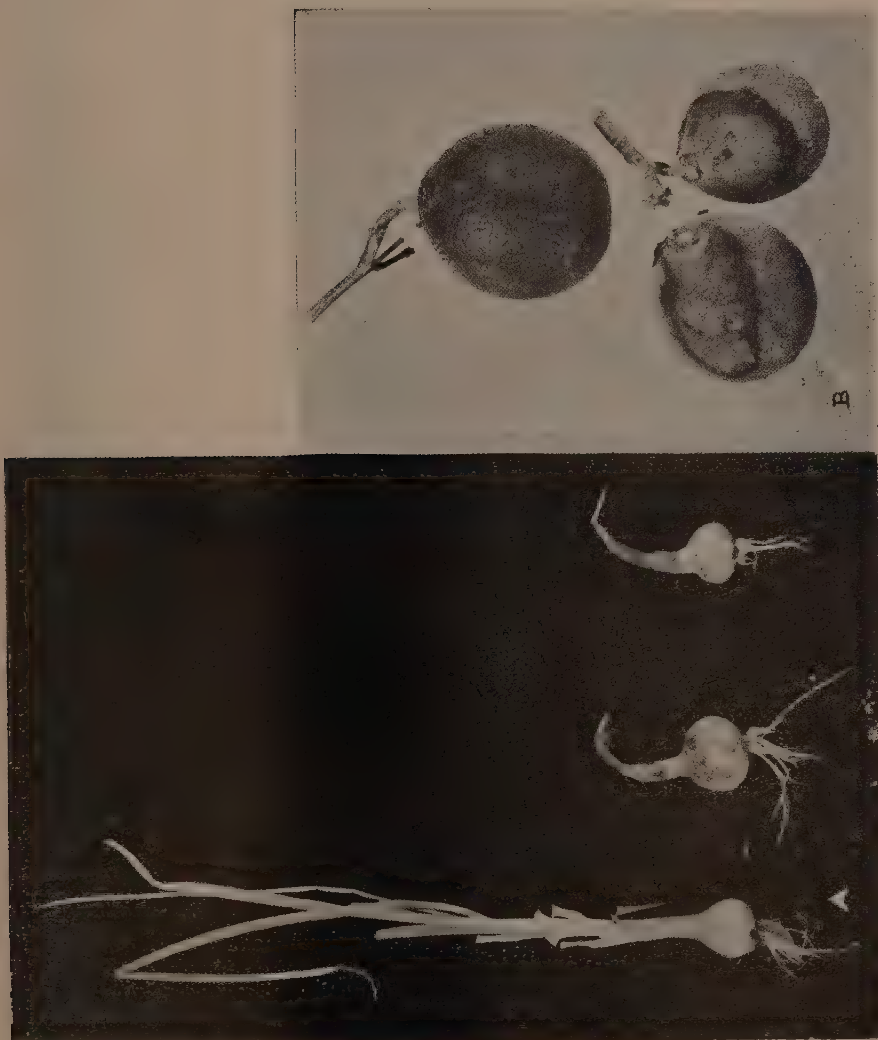


PLATE II



PRINCIPAL DISEASES AND DECAYS OF OAKS AND OTHER HARDWOODS IN INDIA—II

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This paper is intended to record more Hymenomycetes on living and dead oaks, *Quercus* spp., and other associated hardwoods in the Himalayas, in continuation of the first article on the subject (Bakshi and Bagchee, 1950). Some of these fungi occur on conifers, in which case the coniferous hosts are also reported. Many of the fungi are well-known in India and abroad so that a record will be made of their occurrence on oaks. Some, however, require revaluation, and short diagnostic characters of these fungi are given. Others, which are reported for the first time in India, are described in detail to bring out their similarities with the similar forms described by other workers. The specimens examined under each fungus are listed along with the host, locality, date of collection and herbarium number (indicated in italics). Oaks grow in the temperate regions (alt. 6,000—10,000 ft.) of the Himalayas and the divisions surveyed frequently were Simla and Kulu in the Punjab (India), Bashahr in the Himachal Pradesh, Chakrata, Dehra Dun, Almora and Nainital in the Uttar Pradesh from where the specimens under study were collected. Thirty-seven species have been recorded of which 8 are new records in India.

1. *Armillaria mellea* (Vahl.) Quel.

The fungus is a common parasite on conifers like *Cedrus deodara*, *Picea morinda* and *Abies pindrow*. The fungus caused 2 per cent loss in weight on *chir* heartwood in 4 months.

Rare on dead *Quercus incana*, Bhawali, Nainital, U.P., Nov. 1932, *96* ; on *Q. semicarpifolia*, Mundali, Chakrata, U.P., June 1947, *476*, *4804*.

2. *Daedalea flavida* Lev. (Pl. I, fig. 2).

A common destroyer of slash of various hardwoods, occurs all over India. Produces a white, spongy rot. The fungus caused 10 per cent loss in weight on sal sapwood in 4 months.

On dead *Quercus incana*, Molta, Chakrata, U.P., June 1947, *4705*.

3. *Fomes annosus* Fr.

A common fungus in the Himalayas as a parasite and a saprophyte on *Cidrus deodara*, *Picea morinda*, *Abies pindrow* and others. The fungus caused 8 per cent loss in weight on *chir* sapwood in 4 months.

On dead oak, Bodyar, Chakrata, U.P., Oct. 1943, *2369*, *4163* ; Garsha, Kulu, Oct. 1240, *3068* ; on roots of living *Q. incana*, Garsha, Kulu, Oct. 1940, *3073*.

4. *Fomes conchatus* (Pers.) Fr.

Sporophore perennial, thin, conchate, woody ; upper surface concentrically sulcate, not rimose ; context 1—3 mm. thick, brown ; basidiospores hyaline, thin-walled, oval (Text fig. 1a), 4—4.7×4μ ; setae ventricose (Text fig. 1b).

On dead *Q. incana*, Bhawali, Nainital, U.P., May 1927, *1787* ; Garkhet range, W. Almora, U.P., Oct. 1932, *2412* ; on dead *Q. semicarpi-carpifolia*, Gopalpur, Bashahr, Oct. 1941, *3383*, Bahali, Bashahr, Himachal Pradesh, Oct. 1942, *3361*.

5. *Fomes geotropus* Cke. (Pl. I, fig.1)

Sporophore ungulate, applanate, or irregular, woody, margin thick ; upper surface hard, rough, zonations faint or absent, reddish buff consisting of 'light ochraceous buff', 'light ochraceous salmon', 'ochraceous salmon' ; context woody, 'cinnamon buff', 0.5—3cm. thick, hyphae 'warm buff', thick-walled, septate, branched, 4—5.5μ; hymenial surface 'fawn colour' to 'army brown', pores round, 5—6 per mm., pore tubes 'mikado brown' darker than context, 7.7—1.5 cm. long in each layer.

On dead oak, Mundali, Chakrata, U.P., Sept. 1945, *3983*

6. *Fomes leucophaeus* Mont.

Sporophore sessile, reflexed, dimidiate, slightly convex, different annual growths forming tiers one above the other ; margin entire and smooth, woody when dry ; upper surface smooth, conspicuously zonate near the margin, 'ochraceous tawny' to 'cinnamon brown' ; context thick, hyphae 'antimony yellow', thick-walled with lumen nearly obliterated, branched, non-septate without clamp connections, 1.5—2.3μ broad ; hymenial surface plano-convex, 'warm buff', pores round 5—6 per mm., pore tubes 2 to 6 mm. long in each layer, distinct, hyphae mainly thin-walled, rarely thick-walled, hyaline to 'warm buff', branched, septate, clamp connections absent, 1.5—3.1μ broad ; basidiospores light brown, thick-walled, pear-shaped (Text fig. 2) 7.6—10.2×5—5.8μ.

On dead oak, Deoban, Chakrata, Sept. 1949, *5345*. New record in India.

The fungus belongs to *Fomes* owing to the perennial character of the sporophore with smooth spores, and not to *Ganoderma* where the spores are truncate. Lloyd (1901) states that *F. leucophaens*, a common species in America, is alike in general appearance to *F. applanatus*, but differs in character of spores which is smooth in *F. leucophaeus* and echinulate in *F. applanatus*. *F. leucophaeus* Mont appears to be different from *F. annularis* Lloyd since the spores in the latter species are rough as described by Lloyd (1915) though the

sporophores of the two fungi are very much alike. In a later note, Lloyd (1924), however, considers *F. annularis* and *F. leucophaeus* the same as *F. applanatus*. *F. applanatus* (*Ganoderma applanatum* (Pers.) Pat.) has echinulate and truncate spores. We, therefore, prefer to call our present specimen as *Fomes leucophaeus* Mont.

7. *Fomes ostricoloris* Lloyd (Pl. II, fig. 3).

Sporophore sessile, reflexed, or effuso-reflexed to completely resupinate, dimidiate (in reflexed forms) or appearing as circular patches on the host, woody ; margin thick, entire, smooth ; upper surface hard, rough, concentrically sulcate, rimose in older sporophores (Pl. II, fig 3a), 'russet', 'cinnamon brown', when young turning black with age, growing region 'argus brown', 'amber brown' ; context corky to woody, 0.2—2.5 cm. thick, transversely concentrically zoned, with silky lustre, 'mars yellow' 'raw sienna', hyphae thick-walled with very narrow lumen, usually unbranched (Text fig. 7a), individual hyphae 'antimony yellow' under the microscope, septate, clamp connections absent, H-connections frequently present, small papilla-like projections (Text fig. 7b) sometimes present on the hyphae, 2.9—4.3μ broad; hymenial surface (Pl. II, fig. 3b) smooth, uneven, 'antique brown', 'sudan brown,' 'argus brown' with 'cadmium yellow' margin, pores almost round, 6—8 per mm., pore tubes 0.5 to 5 mm. long, disinct ; basidia clavate (Text fig. 7c), 3—4μ broad ; basidiospores yellow, thick-walled, ovoid to subglobose, (Text fig. 7d), 3.2—4.3$\times$2.9—3.2μ ; setae abundant, ventricose, pointed (Text fig. 7e), 'chestnut brown', 19—29.2 (—36.5)$\times$5.8—11.6μ.

Produces white fibrous rot in which dark brown zone-lines are present (Pl. II, fig. 3c). The fungus caused 11 per cent loss in weight on sal sapwood in 4 months.

On decaying logs of *Rhus wallichii*, Kulu, Punjab (India), Oct. 1952, *6169, 6180* ; on decayed logs of *Corylus colurna*, Kulu, Punjab (India), Oct. 1952, *6111*. New record in India.

Cultural Characters :

Growth characters : Mat moderate to very thick, sub-felty to felty, 'pinard yellow' to 'empire yellow'. Oxidase tests yield variable results, diffusion zones sometimes present on gallic and tannic acid agars, or absent at other times, growth also variable. On gentian violet agar, medium sometimes discoloured, though not always, growth good.

Hyphal characters : Aerial mycelium (a) hyphae thin-walled (Text fig. 7f), hyaline, 'light buff', 1.4—5.2μ broad ; (b) hyphae thick-walled (Text fig. 7g), 'yellow ocher', 'tawny', branched, the lateral branches, sometimes very small, appearing as papilla-like outgrowths as in context hyphae, septate, 1.4—5.2μ broad. Submerged mycelium as in aerial mycelium.

Cultures examined : Nos. 35, 35 (a), 35 (b).

8. *Fomes pinicola* Fr.

Sporophore ungulate, woody, large ; upper surface red to black, shiny or dull, resinous, smooth or sulcate ; context corky to woody,

buff, 1—3 cm. thick, hyphae light yellow, thick-walled, unbranched, 3—8μ ; hymenial surface pinkish buff, pores 3—4 per mm., pore tubes 'light buff', 2—6 mm. long in each layer.

A common parasite and saprophyte on conifers like *Picea morinda Abies pindrow* and *Pinus longifolia* in the wood of which it causes a brown cuboidal rot. The fungus caused 54 per cent loss in weight on *chir* sapwood in 4 months.

Uncommon on oak, on dead *Q. lineata*, Darjeeling, West Bengal, Feb. 1950, *5464*.

9. *Fomes rimosus* Berk.

Sporophore perennial, woody, applanate to ungulate ; upper surface concentrically sulcate, rimose, brown to black ; context brown, woody, zonate ; spores oval, brown, thick-walled, 4.6—6.8$\times$4.3—5.3μ ; setae absent.

Common on various living or dead hardwood species (Bagchee and Bakshi, 1950). The fungus caused 6 per cent loss in weight on *sal* sapwood in 4 months.

On dead oak, Kulu, Punjab (India) Oct. 1940, *409* ; Mundali, Chakrata, U.P., Oct. 1941, *444* : Ranikhet, W. Almora, U.P., Nov. 1932, *2444* ; Mundali, Chakrata, U.P., June 1936, *3057*, June 1937, *3077* ; on dead *Q. semecarpifolia*, Chakrata, Aug. 1942, *4137* ; on roots of living oak, Bhawali, Nainital, U,P., June 1943, *4219* ; on *Q. dilatata*, Konain, Chakrata, U.P., Sept. 1946, *4698* ; on green *Q. semecarpifolia*, Mundali, Chakrata, June 1947, *4725* ; on dead *Q. incana*, Simla, Punjab (India), Sept. 1946, *5615*.

10. *Fomes sanfordii* Lloyd.

Sporophore sessile, reflexed, dimidiate, woody, sometimes imbricate, occasionally lobed ; margin thin or thick, entire, smooth ; upper surface soft, smooth when young, becoming hard, rough with age, concentrically sulcate, somewhat rimose in young sporophores, becoming more so with age, 'auburn', 'antique brown' when young turning 'chestnut brown', 'carob brown' to almost black with age ; context corky to woody, up to 0.3 cm. thick, (bounded on the upper side by a dark brown line), 'antique brown', 'amber brown', 'argus brown', hyphae thick-walled with lumen narrow or almost obliterated, unbranched, aseptate (Text fig, 18*a*), 'amber yellow', citron yellow', under the microscope, 2.7—4.2μ broad ; hymenial surface smooth, uneven, 'cinnamon buff', 'clay color' with black margin in older sporophores, pores round to oval, 6—7 per mm., pore tubes upto 12 mm. long, distinct, basidia cylindrical ; basidiospores light yellow, thick-walled, sub-globose to globose (Text fig. 18b), 4.0—4.6$\times$2.9—4.3μ; setae frequent, subulate and ventricose, the latter predominating, pointed (Text fig. 18c), 'chestnut brown', 'mars brown', 17.5—26.2$\times$5.8—10.2μ.

Produces a white spongy rot with dark brown zone lines. The fungus caused 16 per cent loss in weight on *sal* sapwood in 4 months.

On living *Lonicera* sp., Khadrala, Bashahr, Himachal Pradesh, Sept.—Oct. 1941, *3359* ; on living *Lonicera quinquolocularis*, Chakrata, U.P., Sept. 1943, *3685*. New record in India.

Cultural Characters :

Growth characters.—Mat appressed, felty with patches of skin-like membrane. Dark brown zone lines present on the upper and under surfaces. On gallic and tannic acid agars diffusion zones strong, growth* trace and 2.0 cm. respectively ; on gentian violet agar growth vigorous, medium discolored.

Hyphal characters : Aerial mycelium,—(a) hyphae hyaline, thin-walled, branched, septa simple (Text. fig. 18d), 1—1.4μ broad, (b) hyphae hyaline, thick-walled, branched sparsely septate, 1.3—3.6μ broad : (c) hyphae light yellow or brownish yellow, thick-walled with narrow lumen, rarely branched, sparsely septate, (Text. fig. 18e) 1.3—4.3μ broad (broader hyphae comparitively few), (d) hyphae from skin-like area brown, thick-walled with numerous short branches or protuberances, (Text. fig. 18f), interlocking with one another. Submerged mycelium—thin-walled and thick-walled hyaline hyphae as in aerial mycelium, coloured hyphae absent.

Culture examined No. 19.

11. *Fomes scruposus* (Fr.) Cunn.

Sporophore sessile or sub-sessile, reflexed or effuso-reflexed, dimidiate, woody, margin entire, often imbricate ; upper surface hard, rough scrupose, sometimes imperceptibly concentrically zoned, 'hazel' to almost black; context woody, 'tawny', 'cinnamon brown', 'mars brown', hyphae running radiately in the basal part, upto 7mm. thick ; hyphae thick-walled, yellowish brown, branched, (Text, fig. 19a) 3—4.5μ broad, and thin-walled with stag-horn type of branching, septate, without clamp connections, 1.1—4.2μ broad ; hymenial surface rough, uneven, rimose, 'chestnut brown', 'carob brown', with 'hazel' margin, pores round to oblong, 7 - 8 per mm., pore tubes 2—5 mm. in each layer, distinct ; basidia clavate or oblong, 10—14 $\times$ 4—5μ, basidiospores elliptic, hyaline, smooth, 4—5 $\times$ 2.5—3μ (Cunningham, 1948); setae abundant, subulate, very rarely ventricose, (Text. fig. 19b) 'chestnut brown', 24.8—30.6 $\times$ 4.3—5 μ; crystalline bodies long and sharply pointed present in the pore tubes.

Produces a white fibrous heart-rot with dark brown zone lines. On a living tree of *Prunus padus*, Kulu, Punjab (India) Oct. 1952. *6162*. New record in India.

Cultural Characters :

Growth characters : Mat appressed with scanty aerial mycelium, 'Antimony yellow', 'ochraceous tawny', 'russet', 'mars brown'. On gallic and tannic acid agars, the diffusion zones very strong, growth 1 mm. On gentian violet agar, growth good, medium discolored.

*Growth in all cases refers to radial growth in 7 days at 28°C in the dark.

Hyphal characters: Aerial mycelium.—(a) hyphae thin-walled (Text fig. 19c), hyaline, 0.7—1.4μ broad; (b) hyphae thick-walled (Text fig. 19d), light yellow to brownish yellow, 1.4—4.2μ broad. Submerged mycelium.—hyphae thin-walled, hyaline, branched, septate, 0.7—4.2μ broad. Thick-walled coloured hyphae absent.

Culture examined: No. 43.

12. *Fomes senex* Nees and Mont.

Sporophore perennial, applanate, woody, light; upper surface sulcate, brown to black, rough due to knob like growths, not rimose; spores hyaline, oval, 3.2—4.8$\times$2.4—3μ; setae ventricose.

On various living and dead hardwoods (Bagchee & Bakshi, 1950). The fungus caused 21 per cent loss in weight on sal sapwood in 4 months.

On dead oak, Kathian, Chakrata, U.P., Oct. 1939, *257*, June 1936, *2409;* on dead Q. *semecarpifolia*, Kathian, Chakrata, U.P., Oct. 1937, *2454;* on dead oak, W. Almora, U.P., Nov. 1932, *2458;* on living Q. *lineata*, Darjeeling, W. Bengal, *2463*, Feb. 1950, *5458*.

13. *Fomes setulosus* Lloyd.

Sporophore sessile, effuso-reflexed or ungulate, dimidiate, woody; margin entire, thick, stratified; upper surface hard, rough, concentrically ridged and sulcate, somewhat rimose, 'prouts brown', 'mummy brown'; context woody, 'mars brown', 2—4 mm. thick, hyphae thick-walled with lumen almost obliterated (Text fig. 8a), 2.9—4.3μ broad, 'yellow ocher'; hymenial surface smooth, uneven, mikado brown', 'snuff brown'; pores generally round, 5—7 per mm.; pore tubes stratified; basidiospores light yellow to yellow, sub-globose to globose (Text fig. 8b), 4.3—5.8 x 4.3—4.6 μ; setae abundant, ventricose and subulate (Text fig. 8c), 'cinnamon rufous', 13—19.7$\times$5.2—5.8μ.

Produces a white pocket rot.

On a living tree of *Mallotus philippinensis*, Wynad division, South India, Jan. 1946, *580, 4335*.

14. *Ganoderma lucidum* (Leyss.) Karst.

Common on various hardwoods all over India as a parasite and a saprophyte (Bagchee & Bakshi, 1950). The fungus caused 13 per cent loss in weight on sal sapwood in 4 months.

On dead roots of Q. *semecarpifolia*, Deoban, Chakrata, U.P., July 1947, *4683*.

15. *Hydnum coralloides* Scop. (Pl. II, fig. 4)

On a dead branch of a green oak from Mundali, Chakrata, U.P., Oct. 1943, *3722*.

16. *Hydnum erinaceus* Bull.

On dead and living oak, Konain, Mundali, Chakrata, U.P., Sept. 1943, *3654, 3656*.

17. *Hymenochaete nigricans* (Lev.) Pat.

On dead oak, Bhowali, Nainital, U.P., Oct. 1932, *2237*.

18. *Hymenochaete rubiginosa* (Schrad.) Lev.

Usually a wound parasite through cankers and also injury caused by fire. Causes a severe white pocket rot in the wood. The fungus caused 11 percent loss in weight on *sal* sapwood in 4 months.

On dead oak and *Q. semecarpifolia*; Chakrata, Oct. 1943, *4324*, Daran, Bashahr, Himachal Pradesh, Oct. 1941, *4853*.

19. *Hymenochaete tabacina* (Sow.) Lev.

Produces white pocket rot in the wood. The fungus caused 5 per cent loss in weight on *sal* sapwood in 4 months.

On dead *Q. incana*, Chaubattia, Ranikhet, U.P., May 1944, *3729*, Molta, Chakrata, U.P., June 1947, *4703*; on dead *Q. semicarpifolia*, Mundali, Chakrata, June 1947, *4616*. New record in India.

20. *Hymenochaete villosa* (Lev.) Bres.

Produces white pocket rot.

On dead *Q. incana*, Kulu, Panjab (India), Oct. 1940, *4859*.

21. *Inonotus nothofagi* Cunn.

Sporophore sessile, reflexed, applanate with incurved edges, imbricate, light, woody, brittle; upper surface rough with strigose hairs, radiately striate, concentrically zonate, cuticular, 'cinnamon brown' to almost black; context upto 1 mm. thick, 'ochraceous tawny', hyphae 'warm buff', under the microscope with dark brown walls, thick-walled, unbranched, aseptate, $2.3-4.7\mu$ broad; hymenial surface rough, 'tawny', 'russet', 'cinnamon brown', 'mars brown', pores irregular, 5–6 per mm., pore tubes upto 6 mm. long: basidiospores brown, oval to sub-globose, slightly thick-walled (Text fig. 3a), 1 - 2 guttulate, $5-7 \times 4-5.5\mu$; setae dark brown, abundant to rare, subulate or ventricose, pointed, frequently with lateral 'appendages' near the base (Text fig. 3b) $20-31 \times 6-8.6\mu$, usually totally projecting out of the hymenium.

Identification confirmed by G. H. Cunningham. On dead oak, Hatoo - Baghi Lower Bashahr, Himachal Pradesh, Oct. 1941, *5782*, *5784*. New record in India.

22. *Lenzites betulina* (L.) Fr. (Pl. II, fig. 6).

Sporophore sessile, reflexed, dimidiate coriaceous, occasionally imbricate, margin entire, upper surface soft, velvety, concentrically zonate, 'pinkish buff', 'cinnamon buff', 'clay color'; context upto 1 mm. thick, 'pinkish buff', hyaline or nearly so, hyphae thick-walled, hyaline, unbranched, aseptate (Text fig. 4a), $1.5-3.1\mu$ broad; hymenial surface lamellate, lamellae concolorous with the context or darker ('pinkish buff', 'sayal brown'), about 1 mm. apart, 2 mm. to 9 mm. broad, edge

thin, entire, sometimes minutely lacerate; hyaline, thick-walled, filiform, sharp pointed, unincrusted organs present in hymenium, referred to as cystidia by Overholts (Lowe, 1942), $11-25 \times 3-5\mu$: hyphal pegs present, not common.

Produces a white fibrous rot in the wood. The fungus caused 37 percent loss in weight on *sal* sapwood in 4 months.

On dead oak, Daranghati and Bahali, Bashar, Himachal Pradesh, Oct. 1940, 1941, *4000*, *4052*; on dead *Q. incana*, Bhawali, Nainital, U.P., June, 1944, *139*, *2559*, *2561;* On dead *Q. semecarpifolia*, Deoban and Mundali, Chakrata, U.P., Oct. 1943, Sept. 1945, 1946, *3913*, *3947*, *4490*, *4492*, Dhara, Kulu, Punjab (India), Oct. 1940, *3177*.

Cultural characters :

Growth characters: Mat slightly woolly at first, becoming appressed felty with age, rolling over glass surface, white. On gallic and tannic acid agars, (Bavendamm, 1928) diffusion zones strong, growth 0.7 cm. and 2.1 cm. respectively. On gentian violet agar (Preston and Mclennan, 1948), growth a trace, medium not discoloured.

Hyphal characters: Aerial mycelium—(a) hyphae hyaline. thin-walled, branched, with clamp connections (Text. fig. 4 b), $1-4\mu$, broad, (b) hyphae hyaline, thick-walled, aseptate (Text fig. 4 c), rarely branched, $1-3\mu$ broad. Both types common. Submerged mycelium:—as in aerial mycelium.

Culture examined No. 81, 21/K

23. Lenzites eximia B. & C.

Sporophore sessile, reflexed, dimidiate, corky, often imbricate, margin entire; upper surface a little rough, concentrically and radially ridged, concentrically zonate, 'clay color', 'cinnamon'; context upto 1 mm. thick, 'light buff', 'pale ochraceous buff', hyphae hyaline to 'light buff' (under the microscope), thick-walled, with lumen very narrow or almost obliterated, usually unbranched, apparently aseptate (Text fig. 11a), $2.1-5.5\mu$ broad; hymenial surface lamellate, lamellae concolorous with the context or slightly darker, about 1 mm. apart at the margin, 3-8 mm. broad, edge slightly thick near the margin, gradually thinning backwards, entire or often lacerated, the lamellae or gills usually simple, a few are branched, anastomosing at the base; hymenium composed of hyaline, thin-walled, branched hyphae with clamp connections (Text. fig. 11 b), and thick walled, apparently aseptate, branched hyphae with narrow or almost obliterated lumen (Text, fig. 11 c), 'light buff' to 'light ochraceous buff'; basidiospores hyaline, thin-walled, smooth, allantoid (Text. fig. 11 d), $4.3-5.8 \times 1.1-1.4\mu$.

The fungus caused 13 percent loss in weight on *sal* sapwood in 4 months.

On decayed jungle wood, Soja, Banjar range, Seraj division, Kulu, Punjab (India) Oct., 1952, *6164*.

Cultural characters:

Growth characters: Mat thick, wooly to sub-felty, rolling over glass surface, generally white with patches of 'pale ochraceous buff', 'light ochraceous salmon', 'ochraceous tawny' especially near the edge of the slant. Zone lines present on reverse of agar. On gallic acid agar diffusion zones weak, growth nil; on tannic acid agar diffusion zones strong, growth 1.5 cm. On gentian violet agar growth vigorous, medium discolored.

Hyphal characters: Aerial mycelium—(a) hyphae hyaline, thin-walled, branched, septate with clamp connections (Text, fig. 11 e), 1.1—3.0 μ braod, (b) thick-walled fibre hyphae with narrow lumen, rarely branched, apparently aseptate (Text fig. 11 f), 1.8—3.2 μ broad, (c) hyphae from skin-like coloured area with numerous short branches or irregular protuberances (Text fig. 11 g), closely interwoven with fibre hyphae to from a pseudoparenchymatous layer, 'antimony yellow', 'ochraceous buff'. Submerged mycelium—hyphae as in aerial mycelium, but broader upto 5.8μ.

Culture examined No. 79.

24. *Lenzites palisoti* Fr.

Sporophore applanate, brown ('isabelline, according to Lloyd 1920-21), coriaceous to rigid; upper surface 'pinkish buff' to 'cinnamon buff' in trametoid form, and 'tawny', 'ochraceous tawny', 'russet' in daedaloid forms, rough, glabrous, faintly zoned at margins; context upto 1 cm. thick, coriaceous, with faint concentric zones in some, light brown; hymenial surface daedaloid or trametoid, 'sayal brown' to 'snuff brown'.

On dead Oak spp., Jagdeo Block, Ranikhet, W. Almora, U.P., Nov. 1932, *2562;* Gager, Bhowali, U.P., Nov., 1932, *2566;* Deoban, Chakrata, U.P., May., 1934, *2399;* Deoban, Chakrata, U.P., Sept., 1936, *2568;* Mundali, Chakrata, U.P., Oct., 1935, *2401*. New record in India.

25. *Merulius tremellosus* (Schrad.) Fr.

Sporophore sessile, effuso-reflexed, imbricate, resupinate portion thin, papery and translucent; margin slightly dentate, involute; brittle when dry; upper surface rough, hard, tomentose, curling inwards at the margin, 'light buff' to 'pale ochraceous buff'; context hyaline, thick-walled, branched, septate with clamp connections, 1.5—3.8μ broad, longitudinally united to form thick strands; hymenial surface gelantinous, slightly shiny; pores indistinct on the resupinate portion, but distinct in the reflexed portion and in the folds, pores irregular, 'pinkish cinnamon', 'sayal brown', 'russet'; basidia persistent.

The fungus caused 18 per cent loss in weight on sal sapwood in 4 months.

On dead *Q. incana*, Mundali, Chakrata, U. P., October, 1943, 1946, 1949, *3917, 4499, 5370*; Kasol, Kulu, Punjab (India), October,

1940, 1945, *3233, 4018(a)*; on dead Oak and *Q. semecarpifolia*, Bahali and Baghi, Bashahr, Himachal Pradesh, September, October, 1941, June, 1947, *3980, 4303, 4694*.

Cultural characters:

Growth characters: Mat thin, appressed, hyphae condensed in small areas, white. On gallic and tannic acid agars, diffusion zones strong, growth about 2 mm. On gentian violet agar growth vigorous, medium discoloured.

Hyphal characters: Aerial mycelium.—(*a*) hyphae thin-walled or slightly thick-walled, hyaline, branched generally at right angles, septate with clamp connections (Text fig. 5a), and H-connections, 1.5 - 3.8μ broad; (*b*) chlamydospores terminal and intercalary, solitary (Text fig. 5b), 1.5—3.8μ broad. Submerged hyphae—same as in aerial mycelium but chlamydospores absent.

Cultures examined: No. 95, 97.

26. *Peniophora filamentosa* (Berk. and Curt.) Burt.

Sporophore broadly effused, 0.8—1.1 mm. thick, margin fan-shaped giving rhizomorphs; hymenial surface 'ochraceous buff', 'pale ochraceous buff'; basidia clavate, 8.3—12$\times$5μ, sterigmata 4.5$\times$1.4μ; spores hyaline, oval, 3—4$\times$2—2.5μ; cystidia numerous in hymenium and subhymenium, incrusted whole length, hyaline, 40 —60$\times$5—7.5μ, projecting upto 40μ beyond hymenium.

Produces a white pocket rot on oak. The fungus caused 8 per cent loss in weight on sal sapwood in 4 months.

On dead *Q. dilatata*, Mundali, Chakrata, U. P., September, 1945, *3967*, September, 1949, *5331*. New record in India.

Cultural characters:

Growth characters: Mat thin, short aerial and appressed; 'warm buff', 'antimoney yellow' with a patch of 'russet' on the old inoculum. On gallic and tannic acid agars, diffusion zones weak, growth 1 mm. and nil respectively. On gentian violet agar, growth slow, medium slightly discoloured.

Hyphal characters: Aerial mycelium.—hyphae hyaline, thin-walled, branched, septate, thickly incrusted with golden yellow crystals, 3—5.5μ broad. Submerged mycelium—same as aerial mycelium, but without incrustations.

27. *Polyporus adustus* (Willd.) Fr. (Pl. III, fig. 7).

Sporophore sessile, effuso-reflexed, coriaceous, imbricate, margin somewhat thick, even, involute on drying, brittle; upper surface smooth, plano-convex, finely tomentose, light yellow containing 'light ochraceous buff', 'sudan brown'; context upto 4 mm. thick, 'pale ochraceous buff', hyphae longitudinal, hyaline, thick-walled, branched, septate with clamp connections (Text fig. 6a), 4.7—6.2μ broad; hymenial surface smooth, pores round to slightly oblong, 7—10 per mm., 'pale

smoke grey', to almost black, pore tubes 0.1 – 0.2 mm., form a distinct layer separated from the context by a dark line, hyphae in hymenium hyaline, thin-walled (Text fig. 6b), 2.1—5.8μ broad ; basidia persistent, cylindraceous (Text fig. 6c), 4μ broad, basidiospores hyaline, oval, thin-walled (Text fig. 6d), 3.5—4.3$\times$2.5—3μ.

Produces white fibrous rot, in which black zone lines are present. The fungus caused 21 per cent loss in weight on sal sapwood in 4 months.

On dead oak and Q. *dilatata*, Mundali, Chakrata, U .P., August, 1942, July 1945, September 1946, *4134*, *4139*, *4312*, *4486*. Also grows on dead wood of *Alnus*, *Aesculus indica*, *Celtis australis*, *Mallotus philippinsis*, *Picea morinda* and *Abies pindrow*.

Cultural characters :

Growth characters : Mat white, cottony-woolly becoming felty with age. On gallic and tannic acid agars, diffusion zones weak, growth 3.0 and 1.3 cms. respectively. On gentain violet agar, growth vigorous, medium discoloured.

Hyphal chracters : Aerial mycelium—(*a*) hyphae hyaline, thin-walled or thick-walled, branched, septate with clamp connections, (Text fig. 6e), 2.3—3.1 (—7.8) μ broad. (*b*) Oidia hyaline, formed due to fragmentation of thin-walled hyphae, 5.4—15.7$\times$2.3—3.1μ. (*c*) Chlamydospores terminal or intercalary (Text fig. 6f); Submerged mycelium—as in aerial mycelium.

Cultures examined : 105, 119/K.

Bose (1930) reported the occurrence in culture of conidia which were white and round. From a description of the culture of the fungus by Cartwright (1931), it appears that he obtained chlamydospores which he referred to as secondary spores formed terminally and in intercalary positions. Nobles (1948) failed to observe conidia or chlamydospores in her isolates but reported the occurrence of oidia. In our isolates oidia were commonly formed by fragmentation of thin-walled hyphae and from their mode of formation and shape, they cannot be confused with conidia as described by Bose.

28. *Polyporus consors* (Berk.) Stevenson. (Pl. II, fig. 5).

Sporophore sessile, reflexed, dimidiate, corky, imbricate, margin thin, wavy, involute when dry, brittle; upper surface smooth, convex, zonate, minutely wrinkled, 'light ochraceous buff', 'light ochraceous slamon'; context upto 1 mm. thick, hyphae 'pale ochraceous buff' under the microscope, thick-walled, lumen almost absent, branched (Text fig. 9a), 2—4.5μ broad, or hyaline, thin-walled, with clamp connections (Text fig 9b), 2.5 – 4.2μ broad ; hymenial surface 'light ochraceous buff' to 'light ochraceous salmon', irregularly poroid at margins, soon becoming spiny, spines narrow conical, 1—3 mm. long, 2—3 per mm., hymenium continuous between adjacent spines ; basidia clavate (Text fig. 9c), 8.5 –11.5$\times$3.5μ, sterigmata 4, 2.8$\times$0.3μ ; basidiospores hyaline, thin-walled, round to oval (Text fig. 9d), 5—8.3$\times$3.3—5μ ; gleocystidia hymenial, thin-walled, with hyaline granular contents (Text fig. 9e), 14—35$\times$7—10μ

Produces a white fibrous rot. The fungus caused 20 per cent loss in weight on sal sapwood in 4 months.

On dead *Q.semecarpifolia*, Deoban, Kathian, Mundali, Chakrata, U.P., September 1945, 1946, 1949, *3667*, *3697*, *4520*, *5343*, *5346*; Garsha, Kulu, Punjab (India), October 1940, November 1952, *3187*, *3204*; on dead Q. *incana*, Bashahr, *3538*, Gahn, L. Bashahr, *5397*; on green Q. *semecarpifolia*, Simla, Punjab (India), September 1941, *3375*; on dead Q. *dilatata*, Mundali, Chakrata, September 1945, 4001 (a). New Record in India.

Cultural chracters :

Growth characters : Mat appressed felty, woolly at growing region rolling along glass in tubes, white, turning 'light buff' with age. On gallic and tannic acid agars, diffusion zones moderately strong, growth nil and 2.0 cms. respectively. On gentian violet agar, growth good, medium discoloured.

Hyphal characters : Aerial mycelium—hyphae thin-walled, or slightly thick-walled, hyaline, septate with clamp connections and medallions (Text fig. 9f), branched, sometimes swollen at septa, $2.3-3.1\mu$ broad. Submerged mycelium—hyphae same as in aerial mycelium.

Cultures examined : 67, 68, 33/K, 104/K.

Irpex consors Berk. is stated to be common in Japan (Lloyd 1922). That the fungus should be a *Polyporus* and not an *Irpex* is evident from the facts that the hymenium is irregularly poroid at margins and that the hymenium is continuous in between the spines. The sporophores were sent to John A. Stevenson, Principal Mycologist, U.S.D.A., Beltsville Maryland, U. S. A. who writes, 'like most of this doubtful and indefinite genus (*Irpex*), this form is a good *Polyporus*. It forms definite pores which soon become irpicoid. It is very close to *Polyporus biformis* Kl. common in the U.S.A. and to a less extent in Europe. It should clearly be *Polyporus consors* (Berk.) n. Comb.'

29. *Polystictus pergamenus* Fr. (Pl. III, fig. 8).

Sporophore sessile, reflexed, dimidiate, attached by a narrow base, imbricate, margin slightly wavy ; upper surface smooth, plano-convex, rugose, zonate near the margin, finely tomenotse, silky, 'pale ochraceous buff', 'light ochraceous buff' ; context upto 0.75 mm. thick, 'pale ochraceous buff', hyphae thick-walled, lumen almost obliterated, rarely branched (Text fig. 10a), distantly septate, 'light buff' under the microscope, $3.1-5.4\mu$ broad ; hymenial surface concave, rough, 'russet', 'cinnamon brown', 'light ochraceous buff' near the margin, pores small, irregular, 3—5 per mm., pore tubes 0.5 to 1 mm. long ; basidiospores, hyaline, cylindric to slightly curved, thin-walled (Text fig. 10b), $4.3-5.1\times1.7-2.1\mu$, cystidia capitate, clavate, thick-walled (Text fig. 10c), $6-11\ (-15)\times4-6\mu$, projecting upto 8μ beyond the hymenium.

On dead Q. *incana*, Q. *dilatata*, and Q. *semecarpifolia*, Konain, Kathian, Mundali, Chakrata, U.P., July, 1942, 1945, Oct. 1943, June,

1947, *3681, 4130, 4709, 4720, 4459, 4652, 4729*; Narkanda, Bashahr, Himachal Pradesh, Sept. 1941, *155, 366*; Bhawali, Nainital, U.P., June, 1944, *146, 1788.*

Cultural characters :

Growth characters : Mat silky when young, with long parallel appressed silky hyphae, becoming appressed and sub-felty with age, white. On gallic and tannic acid agars, diffusion zones moderately strong, growth nil and 3 mm. respectively. On gentian violet agar growth good, medium discoloured.

Hyphal characters : Aerial mycelium.—(a) hyphae hyaline, thin-walled, branched, clamp connections common (Text fig. 10d), 1.4—4.7μ broad ; (b) fibre hyphae hyaline, thick-walled, unbranched, without clamps, rarely branched with clamps (Text fig. 10e) 1.5—3μ broad ; (c) Cystidia formed of slightly enlarged hyphal tips bearing a head of crystals. Submerged mycelium—thin-walled hyphae as in aerial mycelium.

Culture examined : 153 (a).

Polystictus elongatus Berk. is considered by Lloyd (1914) as merely the tropical form of *Polystictus pergamenus* Fr. of temperate America. Lloyd states that *P. elongatus* in the East takes two forms, one with pileus more silky than the other. The sporophores of the fungus are very much like the sporophores of *P. abietinus* (Dicks.) Fr., but the two species are distinguished by their habitat, the former grows on hardwood species, latter on conifers. The size and shape of the sporophores of two species also differ as stated by Overholts (1915).

30. Polystictus hirsutus Fr.

Sporophore reflexed, coriaceous ; upper surface whitish, greyish to brownish, roughly tomenotse, concentrically zoned ; context white or light yellow, corky, upto 4 mm. thick ; hymenial surface white when fresh, light yellow on drying, pores regular, 2—3 per mm., pore tubes 3 mm. long ; spores hyaline, cylindric, 4—6 $\times$ 1.8μ.

Produces a white spongy rot. The fungus caused 13 per cent loss in weight on sal sapwood in 4 months.

On dead Oak, Nainital, Chakrata, U.P., Oct. 1943, June, 1944, *3664, 3689, 3737.* Also on various hardwoods all over India.

31. *Polystictus versicolor* (L.) Fr. (Pl. III., fig. 9).

Sporophore reflexed, coriaceous when fresh, rigid when dry, attached by a narrow base, imbricate ; upper surface grey, velvety, concentrically zonate with multicoloured zones varying in shades from grey, brown, red and black ; context upto 1 mm. thick, white, corky, limited on upper side by a dark line ; hymenial surface rough, 'pale pinkish buff', 'light ochraceous buff', pores 3—4 per mm., pore tubes 1—2 mm. long, 'light buff' ; basidia cylindric (Text fig. 12a), 13—16 $\times$ 3—4μ, basidiospores hyaline, thin-walled, cylindric to slightly allantoid (Text fig. 12b), 4—5 $\times$ 1.5μ ; hyphal pegs present.

Produces a white fibrous rot with light brown zone lines. The fungus caused 9 per cent loss in weight on sal sapwood in 4 months.

On living Q. *semecarpifolia*, Deoban, Chakrata, U.P. Sept., 1946., *433* ; on dead Q. *incana* and Q. *dilatata*, Mundali, Chakrata, U.P. Sept. 1945, *3954*, *3968* ; on dead oak, Ranikhet, W. Almora, U.P. Nov. 1932, *2348*, *2377*, Narkanda, Bashahr, Himachal Pradesh Nov. 1941, *3422*, *4439*.

Cultural characters :

Growth characters : Mat appressed felty, white. On gallic and tannic acid agars, diffusion zones moderately strong, growth nil and 3.5 cms. respectively. On gentian violet agar, growth good, medium discoloured.

Hyphal characters : Aerial mycelium.—(*a*) hyphae hyaline, thin-walled, with clamp connections (Text fig. 12c), 1.5—4μ broad, rare. (*b*) fibre hyphae hyaline, thick-walled, branched (Text fig. 12d), 1—3μ broad-common. Submerged mycelium.—thin-walled, hyphae as in aerial mycelium.

Cultures examined : 165, 135/K.

32. *Stereum fasciatum* Schw.

Sporophore and the host list described (Bagchee and Bakshi, 1954).

Cultural characters :

Growth characters : Mat thin, aerial mycelium nearly absent, advancing zone indistinct. On gallic and tannic acid agars, diffusion zones strong, growth 7 and 9 mm. respectively. On gentian violet agar, growth weak, medium not discoloured.

Hyphal characters : Hyphae hyaline, thin-walled, much branched (Text fig. 13), septa simple, 1.4—5μ broad.

Culture examined : 217/K.

33. *Stereum hirsutum* (Willd) ex Fr.

Sporophore and the host list described (Bagchee and Bakshi, 1954).

The fungus caused 13 per cent loss in weight on sal sapwood in 4 months.

Cultural characters :

Growth characters : Mat thin, with loose cottony aerial hyphae when young, condensing with age to a somewhat thick felty mats mostly hyaline, condensing to a white mat later, tinge of 'maize yellow, over inoculum deepens to 'buff yellow' with age. On gallic and tannic acid agars, diffusion zones moderately strong, growth 3.5 cms ; on gentian violet agar, growth good, medium slightly discoloured.

Hyphal characters : Aerial mycelium—hyphae mostly hyaline, but yellow in portions which develop stain, thin-walled, septa simple or with clamp connections, latter simple (Text fig. 14a) or in whorls, (Text fig. 14b), 1.4–5μ broad. Submerged mycelium—same as aerial, but hyphae much thinner.

Cultures examined : 212, 18/K.

34. *Stereum lobatum* Fries.

Sorophore and the host list already described (Bagchee and Bakshi. 1954).

35. *Stereum rugosum* Pers.

Sporophore and host list already described (Bagchee and Bakshi, 1954).

Cultural characters :

Growth characters : Mat loose cottony, when young, becoming cottony-felty later, rolls over glass surface. Mostly white, a tinge of 'pale orange yellow' develops at growing region and on mycelium over glass.

Hyphal characters : Aerial mycelium—hyphae hyaline, thin-walled, branched, septa, simple (Text fig. 15), 1.4–4 5μ broad. Submerged mycelium.—same as aerial mycelium.

Culture examined : 20/K.

36. *Trametes gibbosa* (Pers.) Fr.

Sporophore reflexed, attached by a broad base, light, woody on drying, upper surface mostly 'pinkish buff', 'cinnamon buff', brownish red at base, soft, hairy, lightly zoned ; context 'light ochraceous buff', corky, giving a silky appearance when torn, 1–3 mm. thick, hyphae light yellow in mass, individually lightly tinged or nearly hyaline, thick-walled, lumen small or absent, unbranched (Text fig. 16) 3–4μ broad ; hymenial surface brown, poroid mostly, pores 2 per mm. irregular, tending to become labyrinthyform, pore tubes concolorous with context, upto 7 mm. long, forming a distinct layer, hyphae hyaline, thin-walled, 1.4–3μ broad, clamp connections not observed.

On dead oak, Chakrata, U.P., June, 1934,*2503* ; on dead *Q. semecarpifolia*, Dhara, Kulu, Punjab (India) Oct. 1940, *3084*.

37. *Trametes mollis* (Summerf.) Fr.

Sporophore broadly effused, reflexed at margins only, coriaceous; upper surface greyish brown, concentrically zoned, thickly and softly pubescent, hairs forming a compact felt ; context light brown, less than 1 mm. thick; bordered on upper surface by a black line ; hyphae yellow, thick-walled, unbranched or branched (Text fig. 17 a & b), 1.4–3μ broad ; hymenial surface 'wood brown', pores irregular, round at margin, elongated at mature areas, 2 per mm., pore tubes unequal,

upto 1 mm. long in poroid areas, pore cavities white, hyphae thin-walled, lightly tinged or nearly hyaline, branched with clamp connection (Text fig. 17c), 1.4—3μ broad.

Produces white fibrous rot with black zone lines. On dead *Q. semecarpifolia*, Sungri, Bashahr, Himachal Pradesh, Oct. 1942, *3385*.

Forest Research Institute,
Dehra Dun.

Explanation of Plates

Plate I

Fig. 1. Sporophores of *Fomes geotropus* growing on logs of *Picea morinda.*

Fig. 2. Sporophores of *Daedalea flavida,* growing on fallen logs, showing upper and hymenial surfaces.

Plate II

Fig. 3. (*a*) Sporophore of *Fomes ostricoloris* showing upper surface.

(*b*) Sporophore of *Fomes ostricoloris* showing the hymenial surface.

(*c*) White fibrous rot with dark brown zone-lines produced by *F. ostricoloris* in a log of *Corylus colurna.*

Fig 4. A sporophore of *Hydnum coralloides* growing on *Cedrus deodara.*

Fig. 5. Sporophores of *Polyporus consors* on a dead stump of *Quercus* sp. showing upper surface and the irpicoid hymenial surface.

Fig. 6. Sporophores of *Lenzites betulina,* growing on a dead *Q. semecarpifolia,* showing the upper and the lamellate hymenial surfaces.

Plate III

Fig. 7. Sporophore of *Polyporus adustus,* growing on a log of *Pyrus pashia.*

Fig. 8. A cluster of sporophores of *Polystictus pergamenus.*

Fig. 9. A cluster of sporophores of *Polystictus versicolor* on a stem of *Pyrus pashia.*

Explanation of text-figures

Fig. 1. *Fomes conchatus.* *(a)* basidiospores, (*b*) setae, ×1200 ; Fig. 2. *Fomes leucophaeus.* basidiospores, ×1300 ; Fig. 3. *Inonotus nothofagi.* (*a*) basidiospores, (*b*) setae, ×1200 ; Fig. 4. *Lenzites betulina.* (*a*) thick-walled hypha from the context, (*b*) thin-walled hypha in culture, (*c*) thick-walled hypha in culture, ×1300 ; Fig. 5. *Merulius tremellosus.* *(a)* thin-walled hypha in culture, (*b*) chlamydospores, ×1200 ; Fig. 6. *Polyporus adustus.* (*a*) thick- walled hyphae from the context, (*b*) thin-walled hypha from the hymenium, (*c*) basidia, (*d*) basidiospores, *(e)* thin-walled hypha in culture ; *(f)* chlamydospores, ×1200 ; Fig. 7. *Fomes ostricoloris.* *(a)*thick-walled hypha from context, (*b*) context hypha showing papilla-like projections on the wall, (*c*) basidia, (d) basidiospores, *(e)* setae, *(f)* thin-walled hypha in culture, *(g)* thick-walled hypha in culture, ×1200 ; Fig. 8. *Fomes setulosus.* (*a*) thick-walled hypha from context, (*b*) basidiospores, (*c*) setae, ×1200.

Fig. 9. *Polyporus consors.* *(a)* thick-walled hyphae from context, (*b*) thin-walled hypha from context, (*c*) basidia, *(d)* basidiospores, (*e*) gleocystidia, (*f*) thin-walled hyphae in culture, ×1300 ; Fig. 10. *Polystictus pergamenus.* *(a)* thick-walled hypha from context, (*b*) basidiospores, (*c*) cystidia, (*d*) thin-walled hypha in culture, ×1300 ; Fig. 11. *Lenzites eximia.* (*a*) thick-walled hyphae from context, (*b*) thin-walled hyphae from hymenium, (*c*) thick-walled hypha from hymenium, *(d)* basidiospores, (*e*) thin-walled hypha in culture, (*f*) fibre hypha in culture, *(g)* hyphae from pseudoparenchymatous layer, ×1200.

Fig. 12. *Polystictus versicolor.* (*a*) basidia, *(b)* basidiospores, *(c)* thin walled hyphae in culture, (*d*) fibre hyphae in culture, ×1300 ; 13. *Stereum fasciatum.* thin-walled hypha in culture, ×1300 ; Fig. 14. *Stereum hirsutum.* *(a)* thin-walled hypha in culture with simple clamp connections, *(b)* whorled clamp connections on hyphae in culture, ×1300 ; Fig. 15. *Stereum rugosum.* thin-walled hypha in culture, ×1300 ; Fig. 16. *Trametes gibbosa.* thick-walled hyphae from context, ×1300 ; Fig. 17. *Trametes mollis.* *(a* and *b)* thick-walled hyphae from context, *(c)* thin-walled hypha from hymenium, ×1300 ; Fig. 18. *Fomes sanfordii.* *(a)* thick-walled hyphae from context, *(b)* basidiospores, *(c)* setae, *(d)* thin-walled hypha in culture, *(e)* thick-walled hyphae in culture, (*f*) hyphae from skin-like area, ×1200. Fig. 19. *Fomes scruposus.* (*a*) thick-walled hypha from context, (*b*) setae, (*c*) thin-walled hypha in culture, (*d*) thick-walled hyphae in culture, ×1200.

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PLATE I

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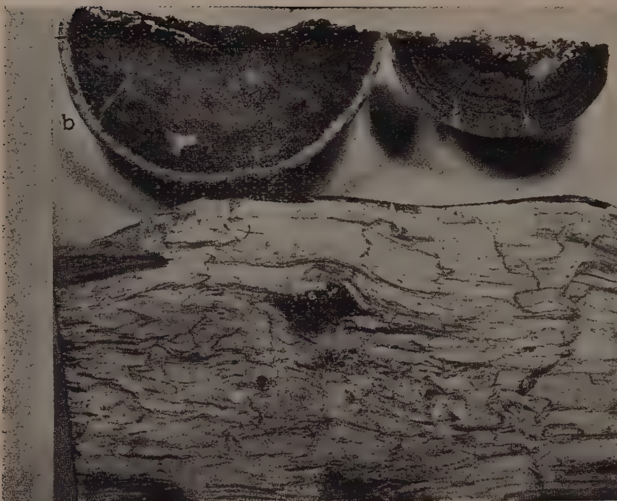
PLATE II



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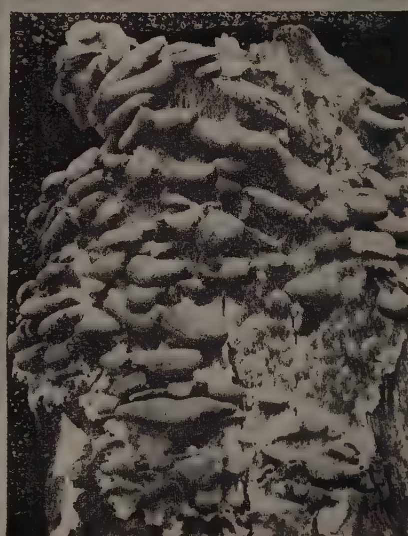

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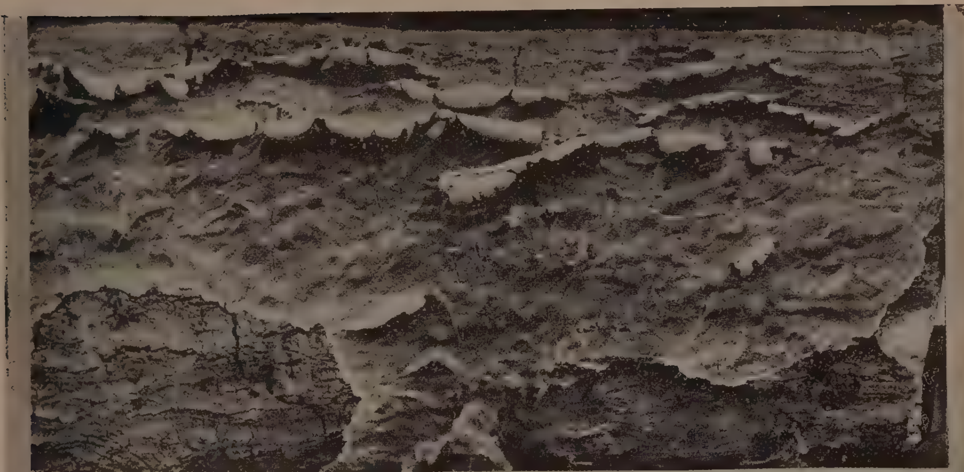
PLATE III



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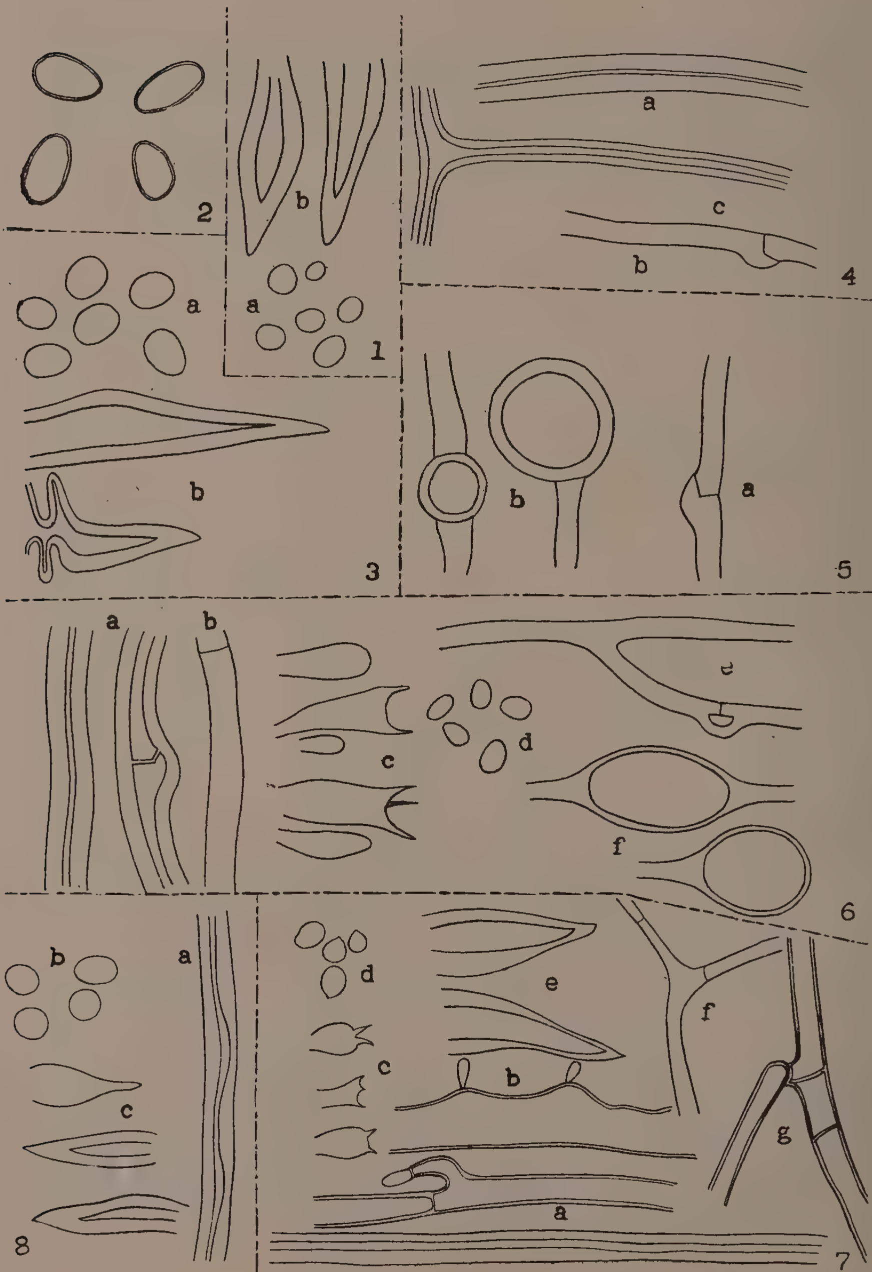
TEXT FIGURES



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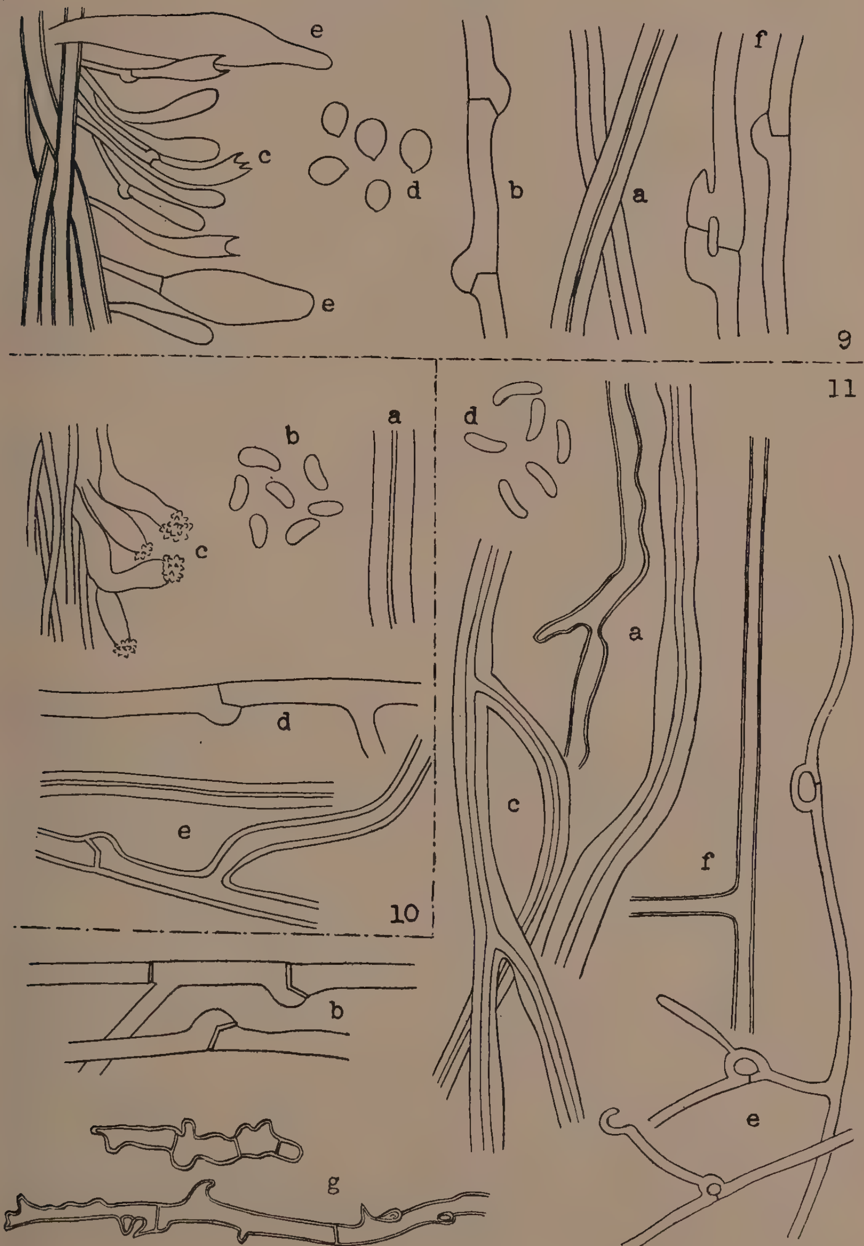

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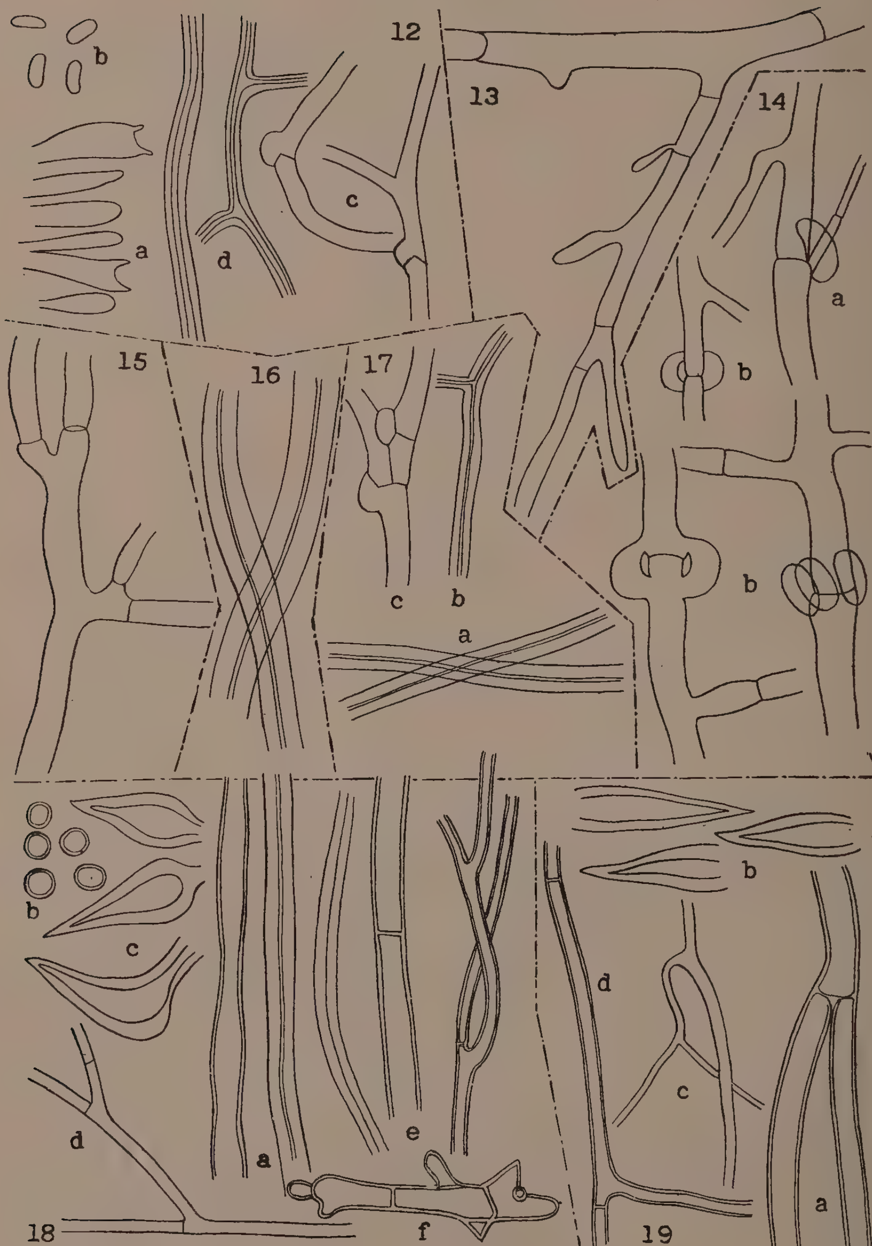

FACTORS AFFECTING VARIABILITY IN CEREAL RUST REACTIONS[1]

II. Variability due to Light

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(Accepted for publication August 4, 1954)

INTRODUCTION

In a previous paper (Shukla, 1953) it was shown that temperature as well as light effect rust development and influence rust infection type on certain wheat varieties.

The present paper deals with further information on the effect of intensity and duration of light on the reaction of the selected wheat varieties to races 15 and 15B of *Puccinia graminis tritici.*

EXPERIMENTAL

(*i*) LIGHT INTENSITY:

The purpose of the first experiment was to determine if race 15B would develop on wheat seedlings exposed to a light intensity insufficient for normal vigour, growth, and metabolism of wheat.

Two sets of seedlings of the nine selected wheat varieties grown under similar conditions at 75°F. were inoculated with race 15B. After 24 hours' incubation one set was kept in a greenhouse under full light; and the other set was placed on the same greenhouse bench but was shaded so that the light intensity was reduced to less than 100 foot candles. Thus the two were under identical conditions except for light. The daytime temperature fluctuated from 85° to 94°F. and the night temperature ranged from 72° to 77°F., except for the last three days when it was 71°, 70°, and 68°F., respectively (Table 1a). The light intensity for the non-shaded plants fluctuated greatly with outdoor weather conditions. It varied from 2800 to 6000 foot candles on six days of the period, but from 520 to 2000 foot candles on five days (Table 1a). The maximum light intensity available to the shaded plants ranged from 15 to 100 foot candles except on two occasions when it was 120 foot candles. Rust notes were taken two weeks after inoculation.

(a) *Fffect on the period of incubation :*

The rapidity of rust development differed under light and shade. The chlorotic flecks of rust infection were noted on the fifth day following inoculation on plants in full light but it took seven days for the appearance of flecks on shaded plants. Furthermore the flecks were less abundant on plants under shade than on plants in full light.

1 The work was carried out at the University of Minnesota, U.S.A., under Drs. E. C. Stakman and Helen Hart. Sincere thanks are due to them.

Rust sporulation was observed on the sixth day after inoculation on plants in full light but nine to ten days were needed for the development of minute uredia on susceptible plants under shade.

(b) *Infection types produced:*

These were normal under light but very abnormal under shade. Under full light Lee, Mida, Marquis, Newthatch, Mindum, and Stewart were susceptible to 15B, infection types ranging from 4 to 4++ (Table 1). Under the same conditions Frontana had infection type 3-c, while the two Kenyas were moderately susceptible (infection type 3cn).

The most noticeable difference under light and shade was on the development of rust mycelium. On all the varieties the rust mycelium can grow with little light but the rust does not sporulate well at the same low light intensity. Excellent growth of mycelium at low light intensity might result partly from the fact that chlorosis and necrosis of host cells proceeds very slowly at low light intensity. The radius of mycelial development was approximately twice on plants under shade in comparison to that under light (note Lee in Fig. 1). Rodriguez (1945) had also noticed a similar extensive spread of mycelium at low light intensity when Little Club wheat was infected with race 38 of *P. graminis tritici*. Uredia that developed on all the shaded varieties except Frontana were very minute although the vegetative mycelium was growing extensively (Table 1 and Fig. 1). Moreover all the plants under shade were yellowish and weak. It seems that lack of light affected the physiology of plants and thus the host-parasite complex was also affected.

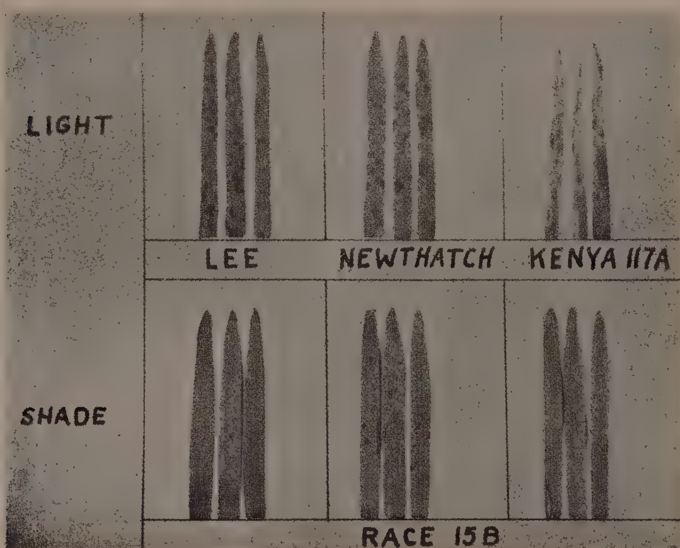

Fig. 1.—Development of race 15B of *Puccinia graminis tritici* on Lee, Newthatch, and Kenya 117A wheats under light and shade.

TABLE 1

Reaction of nine varieties of wheat to race 15B of **P. graminis tritici** *under light and shade in the greenhouse*

Variety	Reaction in light	Reaction under shade
Kenya 58[a]	3 cn.	Mycelium extensive ; uredia minute and few
Kenya 117[a]	3 cn.	—do—
Frontana	3—c	Mycelium extensive ; flecks but no uredia
Newthatch	4 to 4+	Mycelium extensive ; uredia of type 3 and numerous.
Lee	4	Mycelium extensive ; uredia of type 4 and minute.
Mida	4	—do—
Marquis	4	—do—
Mindum	4 to 4+	—do—
Stewart	4+to 4++	—do—

a. A general leaf tip necrosis was produced on the infected plants.

TABLE 1a

Temperature and light measurements during the period of experiment summarised in Table 1[a]

Consecutive days	Average temperature in degrees F.		Maximum light intensity in foot candles	
	Day	Night	Light	Shade
1	72[b]	72[b]	...	...
2	90	77	...	...
3	85	75	600	20
4	85	77	750	80
5	85	76	4000	120
6	92	73	5000	80
7	94	76	2800	70
8	93	73	4000	30
9	90	73	2000	30
10	85	72	520	15
11	86	71	1400	30
12	85	70	3500	100
13	90	68	6000	120
14	Final notes			

a. Many days were cloudy and rainy.
b. Temperature in the incubator.

After two weeks the shaded plants were exposed to full light. Within five days following the change, race 15B produced infection types on these plants similar to the infection types produced on the plants that had been under full light since the inoculation. Similar results were obtained by Rodriguez (1945) who worked with Little Club, Marquis, Reliance, Mindum and Kubanka wheats and stem rust races 19, 38, 59 and 59A.

On the shaded Frontana and Kenya wheats no chlorosis and necrosis and also no leaf tip necrosis in association with 15B were produced.

On the basis of the present experiment and the experience in previous ones it can be said conclusively that intensity of light influences the rate of development and the amount of chlorosis and necrosis of host cells surrounding a rust pustule. It also affects the general leaf tip necrosis produced on Kenyas infected with 15B.

Because curtailment of light to less than 100 foot candles was considered too drastic a reduction in light for satisfactory growth of the cereal plants, other experiments were made with different ranges of light intensities. In an attempt to compensate in some measure for the effects of light reduction, some of the wheat seedlings were given a complete nutrient solution during the period of rust development.

(*ii*) LIGHT INTENSITY AND NUTRIENT :

Seedlings of Lee, Kenya 117A, Frontana, and Mida were planted at 75°F., six sets were inoculated with race 15 and another six sets with 15B. After 48 hours' incubation in moist chamber, duplicate pots of each race-variety combination were placed at three different light intensities in a greenhouse at 86°—98°F. during the day and 80°F. at night (Table 2a). Pots on the open bench received full light which varied from day to day according to the weather outside but which averaged about 4500 foot candles during the two weeks when rust developed. The plants shaded by a frame work covered with a single layer of cheese cloth received approximately half of the normal light intensity of the open bench. A cage covered with a double layer of cheese cloth reduced the light intensity to about one quarter for the rest of the plants.

One pot of each race-variety combination under the three different light intensities received 50 ml. of complete nutrient solution (Shukla, 1953) daily during the period of rust development (July) and another pot, the control, received 50 ml. tap water.

Rapidity of rust development was the same in three light intensities. Rust flecking and sporulation took five and six days, respectively, following inoculation. However, less abundant flecks and smaller uredia were noted under one fourth light in comparison to full light and half light.

Plants given the complete nutrient solution were more vigorous and healthier than the control plants. Under full light race 15 sporulated better and produced slightly higher infection types on all

the varieties that received nutrient when each variety was campared with its counterpart that received only water. The same was true for race 15B on the two most susceptible varieties, Lee and Mida. For example, on Kenya 117A with nutrient the infection type produced by race 15 was 4—but on the control it was only 3++ (Table 2). On Lee and Mida inoculated with 15B and under full light, infection type 4+ developed on nutrient supplied plants and type 4 on controls. In Kenya 117A and Frontana plants infected with 15B and under full light, however, no difference in infection type was observed in plants with nutrient and without nutrient (Table 2).

Under half light and one quarter light there generally was no observable effect of the nutrient on the rust infection types developed. The only exceptions were noted with race 15 and under one quarter light. Infection type 3—appeared on the control Kenya 117A plants while infection type ranged from 3—to 3 on the same variety given nutrient (Table 2). On Mida too an infection type 3—developed on the plants with nutrient whereas type 3=appeared on the control (Table 2).

TABLE 2

Infection types produced by races 15 and 15B on seedlings of four wheat varieties grown at different light intensities and with (+) or without (—) nutrient

Rust race and wheat variety	Nutrient	Infection at[a]		
		Full light	Half light	Quarter light
Race 15				
Lee	+	1+to 1++	0 ; to 1	0 : to 1
	—	1 to 1+	0 ; to 1	0 ; to 1
Kenya 117A	+	4—	3	3—to 3
	—	3++	3	3—
Frontana	+	3c	3=c	3=
	—	3—c	3=c	3=
Mida	+	4—to 4	3—	3—
	—	3 to 3++	3—	3=
Race 15B				
Lee	+	4+	4—to 4	4—to 4
	—	4	4—to 4	4—to 4
Kenya 117A[b]	+	3—to 3cn	3=cn	3=
	—	3—to 3cn	3=cn	3=
Frontana	+	3c	3=c	3=
	—	3c	3=c	3=
Mida	+	4+	4	4
	—	4	4	4

a. *c* means chlorosis and *cn* indicates chlorosis and necrosis accompanying uredia.

b. Leaf tip necrosis was present under full light and half light in the two treatments.

TABLE 2a

Temperature and light measurements during the period of experiment summarised in Table 2

Consecutive days	Average daytime temperature in degrees F.[a]	Maximum light intensity in foot candles		
		Full light	Half light	Quarter light
1	72[b]	...	...	...
2	72[b]	...	...	...
3	92	6100	3000	1600
4	96	6000	2900	1400
5	98	5000	2400	1100
6	90	3800	1800	1000
7	86	1400	700	400
8	92	6000	2900	1300
9	95	5000	2300	1200
10	86	2400	1100	500
11	95	3200	1700	900
12	94	5000	2400	1200
13	98	5000	2600	1400
14	Final notes			

a. The night temperatures were around 80°F.

b. Temperatures in the incubator.

Reduction of light intensity to approximately 1000 foot candles inhibited the production of chlorosis and necrosis in certain of the rusted wheats and it prevented the general leaf tip necrosis that so frequently occurred in the Kenya wheats infected by race 15B.

After the demonstration that intensity of light might influence various processes in rust development, vegetative growth of the mycelium, sporulation of the rust fungus, and chlorosis and necrosis of host cells, the effect of the duration of light on rust development was determined.

(*iii*) DURATION OF LIGHT :

Lee, Kenya 58, Frontana, and Newthatch were inoculated in seedling stage and kept for 48 hours in the moist chamber at 75°F. Three sets were infected with race 15 and another three with 15B. One set from each inoculation was placed on a greenhouse bench in sunlight for approximately 14 hours during the entire day. A second set from each inoculation was kept on the same bench but was provided with only eight hours of daily sunlight between 8 : 30 A.M. and 4 : 30 P.M. and was covered at 4 : 30 P.M. each afternoon so that the plants were in darkness until the next morning. The third set of each inoculation was placed on the same bench but was given only four hours of daily sunlight between 10 A.M. and 2 P.M. It was covered from 2 P.M. each

afternoon to 10 A.M. the next morning. Thus three different day lengths, 14-hour, eight-hour, and four-hour, were tried. The temperature and light conditions during the period of experiment are recorded in Table 3a.

The rate of rust development was not influenced by different day lengths. On the sixth day after inoculation rust flecks were noted in abundance on plants under 14-hour and eight-hour day lengths but fewer were noted on plants under a four-hour day. Rust uredia developed on all the plants on the seventh day following inoculation.

Both rust races sporulated better on all varieties given a 14-hour day than on plants with a four-hour day (Table 3). For example on Newthatch races 15 and 15B both produced infection type 4 to 4+ at 14 hour day while at four-hour day only type 4—was produced. The same was true for Lee, Kenya 58, and Frontana inoculated with 15 and 15B. In all the varieties rust sporulation with an eight-hour day was either equivalent to or only slightly less than sporulation with the 14-hour day (Table 3).

TABLE 3

Infection types produced by races 15 and 15B of **P.graminis tritici** *on seedlings of four wheat varieties grown under different day lengths.*

Rust race and wheat variety	Infection at		
	14-hour day	8-hour day	4-hour day
Race 15			
Lee	1 to 1+	1 to 1+	1− to 1
Kenya 58	4 to 4+	4	4− to 4
Frontana	3c	3c	3−c
Newthatch	4 to 4+	4 to 4+	4−
Race 15B			
Lee	4 to 4+	4	4
Kenya 58[a]	3cn	3− to 3cn	3−
Frontana	3c	3c	3−c
Newthatch	4 to 4+	4 to 4+	4−

a. General leaf tip necrosis was present on the infected plants.

Kenya 58 inoculated with 15B had a marked chlorosis and necrosis accompanying the rust lesions and also a general leaf tip necrosis under 14-hour and eight-hour days (Fig. 2), while under the four-hour day there was complete absence of the symptoms of resistance (Fig. 2). This shows that the chlorosis and necrosis and the general leaf tip necrosis produced in the association of Kenya 58 and race 15B is influenced by the duration of light as well as the intensity of light. A day length between six and eight hours probably is necessary for the macroscopic evidence of injury to the host cells.

TABLE 3a

Temperature and light conditions during the period of experiment summarised in Table 3.

Consecutive days	Average greenhouse temperature in degrees Fahrenheit		Maximum light intensity in foot candles
	Day	Night	
1	72[a]	72	—
2	72[a]	72	—
3	98	85	5000
4	95	85	5000
5	96	82	5500
6	96	83	5000
7	95	85	1000
8	95	79	5000
9	96	85	5500
10	98	85	2800
11	98	86	5500
12	92	80	5000
13	85	75	600
14	Final notes		

a: Temperatures in the incubator.

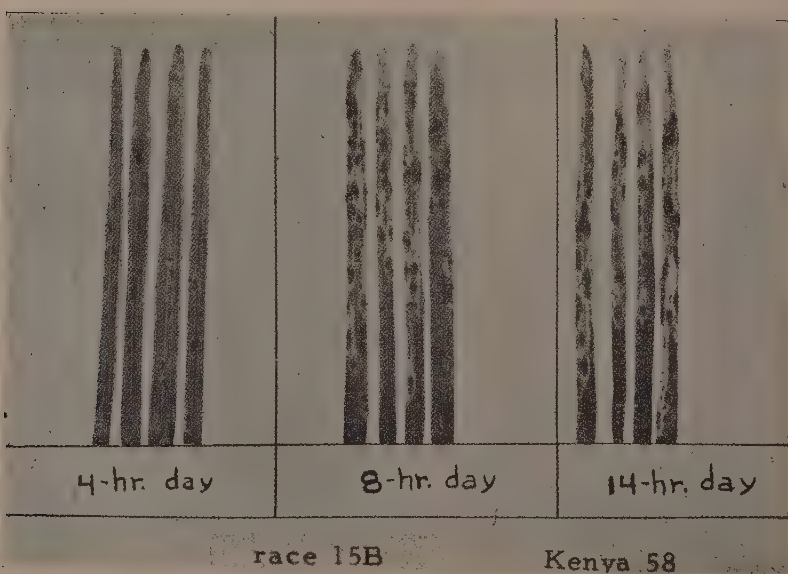

Fig 2. Development of *Puccinia graminis tritici* race 15B on seedlings of Kenya 58 wheat grown under different day lengths.

Discussion

Light as well as temperature may be responsible for certain variations in rust reactions, but light did not produce similar changes in rust reaction as did temperature. The effect of light was usually secondary. It affected the rate of the rust development, vegetative growth of the mycelium, primary and secondary sporulation, chlorosis and necrosis and also the general leaf tip necrosis that was associated with infection of the two Kenyas by race 15B of *Puccinia graminis tritici*. A light intensity of 100 foot candles or less permitted a good vegetative growth of the rust fungus in susceptible hosts but very poor sporulation. A light intensity of more than 2000 foot candles was suitable for rust sporulation but an intensity of 3500 foot candles or more improved sporulation and yet also increased the amount of chlorosis and necrosis of host cells surrounding uredia on resistant hosts. The degree of general leaf tip necrosis in the Kenya wheats rusted by race 15B also was increased at high light intensity. It is difficult to say whether the effect of increased light is directly on the host or the parasite. As the host cells become chlorotic under increased light, however, it appeares that a hypersensitivity to the fungus results in rather sudden death of the host cells. As a result, further, growth of the fungus is checked.

Duration of light appears to have similar effects as the intensity of light. A day lengh of eight hours or more provided sufficient light for normal rust sporulation and for the appearance of chlorosis and necrosis of host cells, while a day length of four hours decreased the amount of sporulation and there was complete absence of chlorosis and necrosis and also of the general leaf tip necrosis in the Kenyas rusted by 15B.

The application of complete nutrient solution also had a seconary effect. It provided for a better growth of the host and it favoured a better rust sporulation. Basic resistance or susceptibility of the hosts to races 15 or 15B, however, was not changed by the application of nutrient solution. Apparently the effect of the nutrient is a direct one on the hosts and an indirect one on the pathogen.

Summary

The rust reactions of nine wheat varieties, Lee, Kenya 58, Kenya 117A, Frontana, Marquis, Mida, Newthatch, Mindum, and Stewart, to races 15 and 15B of *Puccinia graminis tritici* were studied under different conditions of light.

A light intensity of 100 foot candles or less during the period of rust development was sufficient for extensive vegetative growth of the mycelium but there was very poor tust sporulation and an absence of chlorosis and necrosis and also general leaf tip necrosis.

Light intensity of 3500 foot candles or higher intensified the primary and secondary rust sporulation and also the chlorosis and necrosis of host cells surrounding uredia. It also increased the amount of general leaf tip necrosis in the association of 15B and the Kenya wheats.

Different light intensities did not induce a reversal of the rust reaction in Kenyas infected with 15 or 15B as did the different temperatures.

A day length of 14 or eight hours accelerated primary and secondary rust sporulation, the development of infection types, and also the chlorosis and necrosis of host cells around uredia. A day length of four hours delayed rust sporulation and development of the infection type and it prevented chlorosis and necrosis of the host cells.

Under a day length of four hours there was a complete absence of general leaf tip necrosis in the association of race 15B and the Kenyas.

Application of a complete nutrient solution did not produce any significant change in rust reaction, but favoured a better plant development and better rust sporulation in almost all the cases wherever it was applied.

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DISEASE APPRAISAL OF STEM-GALL OF *CORIANDRUM SATIVUM* L.

J. S. GUPTA

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INTRODUCTION

The stem-gall disease of coriander is caused by *Protomyces macrosporus* Unger. The disease appears in the form of tumour-like swellings visble on all the aerial parts of the plant. The life-history of the parasite has long been investigated but very little is known regarding disease intensity and loss caused by the parasite. In this paper observations have been recorded to correlate the disease intensity with loss in yield in a cultivator's field.

METHOD AND MATERIAL

During *rabi*, 1952-53, observations were noted in mature plants on disease intensity, growth (dry weight) and yield of plants in a cultivator's field near Gwalior where the disease is prevalent. One hundred plants were harvested at random by cutting them at the base, and brought carefully in separate large envelopes to the laboratory at Agra College, where observations were recorded.

Disease Appraisal: An attempt has been made to reduce the visual observations of symptoms to a quantitative index. One whole plant with a total score of 100 points was divided into three parts: main stem (40 points), pedicels (20 points) and fruits (40 points). The scoring for stem depended roughly on the extent and density of tumours, for pedicels on the length diseased and for fruits on the approximate number diseased in relation to the total number of fruits formed. Thus a fully diseased plant scores 100 points if the tumours are densely distributed along the whole length of the stem, and all the pedicels and fruits are diseased. A healthy plant without any symptoms scores a total of 3 points, one for each of the three parts similar to the method followed by Naumov (1924).

Observations on the height of the plant, dry weight of the shoot (without fruits), number and dry weight of healthy and diseased fruits were recorded to correlate disease intensity.

Loss Estimate: Chester (1950, p. 295) suggests the 'Individual Method' for estimating loss by working with 100 pairs of healthy and diseased specimens from the same field. This was not possible in the present investigation, since the selected field was widely infested and 100 samples each of healthy and diseased plants could not be obtained. Thus loss has been estimated as percentage on the total expected yield for each plant as follows:

Loss % $= \frac{a-\gamma}{a} \times 100$, where a is total expected yield, i.e. total number

of fruits (both healthy and diseased) × mean weight of a healthy fruit of the same plant and y the actual yield of healthy fruits by the plant.

Various simple correlation coefficients (r) have been calculated to bring out the relationship between disease intensity, growth (dry weight), yield and loss due to diseased fruits. Regression coefficient (b) is also calculated for loss in yield with disease intensity, as their r value is highly significant.

RESULTS

Observations recorded on hundred random plants are summarised below:

TABLE I

Observation on disease intensity, growth and yield.

Nature of observation	Mean of 100 plants	
1. Disease intensity score:		
i. On stem	10.75	± 1.03
ii. On pedicels	4.91	± 0.47
iii. On fruits	7.37	± 0.92
iv. Total	23.00	± 2.26
2. Height of the plant in inches	34.55	± 0.69
3. Growth (dry wt.) of the shoot (without fruits) in grams	12.79	± 1.34
4. Yield of healthy fruits in gms.	3.18	± 0.31
5. Yield of diseased fruits in gms.	1.32	± 0.30
6. Number of healthy fruits	345.2	
7. Number of diseased fruits	61.4	
8. Total number of fruits	406.6	

1. Total expected yield in gms.: $0.18 \times 406.6 \div 345.2 = 3.74$
2. Loss in expected yield in gms.: $3.74 - 3.18 = 0.56$
3. Loss % on total expected yield: $0.56 \times 100 \div 3.74 = 14.97\%$.

The average disease intensity on stem (11 points out of a total of 40) was greater than either on pedicels (5 out of 20) or on fruits (7 out of 40). Thus there is a gradual decrease in disease intensity from the stem to the fruits, indicating perhaps the course of the pathogen. It is further supported by the correlation coefficient (+0.7417, significant at 1% level) between disease intensity on stem and that on fruits.

In the absence of 100 pairs of healthy and diseased plants, loss in yield per plant due to the disease is estimated as percentage of the actual yield of healthy fruits on the total expected yield for each

plant. Thus the mean loss in yield per plant comes to about 15% with a mean of total disease intensity of 23% (the total disease appraisal rating being 100 for fully diseased plant).

Correlation coefficients between yields and disease intensity are summarised below:

TABLE II

Correlation coefficients between yields of (i) healthy and (ii) diseased fruits, and disease intensity.

Yields	Disease Intensity			
	Stem	Pedicels	Fruits	Total
i. Healthy fruits	−0.0570	−0.0944	−0.2216*	−0.1355
ii. Diseased fruits	+0.5770**	+0.6461**	+0.5289**	+0.6460**

* Significant at 5% level. ** Significant at 1% level.

The yield of healthy fruits is not related to the disease intensity of various parts except on fruits, the r value (−0.2216) for the last relationship being quite low but significant at 5% level, indicating that there is a slight negative correlation between the two.

On the other hand the disease intensity on stem, pedicels, fruits and total disease intensity are closely correlated with the yield of diseased fruits, all the r values being significant at 1% level.

TABLE III

Correlation coefficients (r) between estimated loss in yield (% loss on total expected yield) and disease intensity.

Disease intensity	r values
Stems	+0.6875**
Pedicels	+0.7490**
Fruits	+0.9787**
Total	+0.9016**

** Significient at 1% level.

All the r values are highly significant, indicating a very close positive correlation between disease intensity and loss in yield.

TABLE IV

Correlation coefficients (r) between (i) height of the plants (ii) dry weight of the shoot, and disease intensity and certain other factors.

Factors	*r* values	
	(i) Height	(ii) Dry wt. of the shoot.
1. Disease intensity on stem	+0.2293*	+0.4897**
,, ,, pedicels	+0.4429**	+0.3897**
,, ,, fruits	+0.1016	+0.4240**
Total disease intensity	+0.1926*	+0.4878**
2. Loss in expected yield %	+0.1357	+0.4509**
3. Actual yield of healthy fruits	+0.4856**	+0.4376**
4. Actual yield of diseased fruits	+0.2697*	+0.8137**

* Significient at 5% level. ** Significient at 1% level.

The *r* values between height of the plant and the other factors (except the disease intensity on fruits and loss in expected yield) are significant. But the *r* values between dry weight of the shoot and the other factors (recorded in the last column of the table) indicate better correlations, particularly between the dry *weight* and yield of diseased fruits (r=+0.8137, significant at 1% level).

It is thus clear that the more vigorous the plants (as indicated by the dry weight particularly), the greater is the disease intensity, as also the actual yields of healthy and diseased fruits, and the estimated loss in expected yield. However, the *r* value (+0.8137) between dry weight of the shoot and yield of diseased fruits, as also the significant *r* value (+0.4376) between dry weight and actual yield of healthy fruits are interesting. The regression values (*b*) for yields of diseased and healthy fruits on dry weight of the shoot are 0.18 and 0.101 *i.e.*, for every 10% increase in dry weight, the yields of diseased and healthy fruits increase by 1.8% and 1.01% respectively. It shows that the vigour of the pathogen increases with the vigour of the host, which however, is not completely dominated.

As correlation coefficients between disease intensity and loss % are highly significant, the regression value (*b*) is calculated for loss % on the total disease intensity which comes to 0.89 *i.e.*, for every 1% increase in disease intensity, loss in expected yield amounts to 0.89%.

Discussion

Sampling technique and statistical interpretation : Chester (1950 p. 217) points out that "estimates of disease or losses were generally approximate without any measurements and are often not correct", and suggests that "unless a purely random method of sampling is employed, there is a tendency for a plant pathologist's disease-loss estimates to be biased by a complex of several factors". The method adopted in the present studies, selecting plants at random from an infected field, is similar to the 'Individual Method' of Chester (1950, p. 295) and is suited for observations in cultivator's field. However, the method of selecting, at random units each of one square yard (Sallans and Ledingham, 1943) would give a better idea of disease loss on an area basis. These methods involve a standardisation in fixing a minimum number of sampling units which will represent truly the condition of the field.

Sampling at the time of harvest facilitates a more detailed and fairly correct appraisal of disease-loss relationship, as the work can be carried out leisurely in the laboratory, a method followed by Popp (1947) in his studies on bunt of wheat.

Disease appraisal : The use of general terms as "worse than usual" "very injurious" etc., to describe the disease intensity has been deprecated by Chester (1950, p. 209). Quantitative estimates or approximations for disease intensity enable a better comparison with losses. Vasudeva (1946) supports his descriptive indices for mosaic by photographs.

Generally, disease intensity on a plant is appraised in terms of rating or score from visual symptoms. McKinney's five categories (1923) of diseases intensity were converted to twelve categories by Horsfall and Baratt (1945). Reducing the categories to few, minimises the total work. Greater accuracy can, however, be achieved by the method followed in the present studies. The total rating of a fully diseased plant comes to 100 points, spread over the main stem (40), pedicels (20) and fruits (40). The healthy plant scores three points, one each for the three sub-units (stem, pedicels and fruits). Naumov's scoring comes to 100 for a fully diseased plant and unity for a totally healthy plant (Naumov 1924). In the present method the score of each subunit depends on the extent of the disease (on the length for stems and pedicels and on the approximate number for fruits). The accuracy thus obtained is reflected in the significant correlation coefficients between disease intensity on different parts and loss in yield. A further advantage is gained in the present method of scoring since the total score for each plant gives the percentage disease intensity.

Estimate of loss in yield : Generally loss in yield is estimated from a comparison with yield from healthy plants under conditions of maximum infestation in greenhouses or small plots under controlled conditions (Pal, 1936 ; Vasudeva, 1946 ; Agarwal 1948). Chester (1950, p. 295) suggests a random selection of 100 pairs of healthy and diseased plants from the field under his 'Individual Method'. In these studies, it was difficult to follow this method because of wide infestation of the

crop. So, in the present paper, loss is estimated for each plant from the actual yield of healthy fruits and total expected yield ; the latter is obtained for each plant from a consideration of the mean weight of a healthy fruit of the same plant and the total number of fruits (both healthy and diseased) produced by the plant.

Correlation Coefficients : In systemic infection, disease intensity on different parts would be normally correlated with one another. Horsfall and Heuberger (1942) obtained a linear relationship between infection index on leaves and fruits with stem-end rot of tomato, but their conclusions were not based on r values. In the present studies, a significant positive correlation (+0.7417) is obtained between disease intensity on stem (mean value 19.75) and that on fruits (mean value 7.37) Thus it indicates a spread of the disease from the stem upwards.

Disease intensity and loss in yield : Sallans (1935) observed in root rot of wheat and barley, the subcrown lesions are more significantly correlated with grain yield reduction than lesions underground. In the present studies the r value (+0.9787, significant at 1% level) between disease intensity on fruits and % loss in yield is much higher than the value (+0.6875) between disease intensity on stem and % loss in yield. Such observation can lead to a considerable decrease in the amount of labour in estimating disease-loss by restricting observations on disease appraisal to a small portion of the plant.

Regression values for loss in yield on disease intensity have been calculated by several workers in order to forecast losses. According to Greaney (1933 a, b, 1934) an increase in rust by 10% leads to 6.9% loss in yield. Afanasiev and Morris (1942) calculated a loss of 3.5% of potential crop (sugarbeet) with every increase of 5% disease. Machacek (1943) observes that every 10% increase in root-rot of wheat leads to 3% crop loss. In the present preliminary studies, a 10% increase in total disease intensity results in a 8.9% loss in expected yield.

Summary

The paper deals with disease-appraisal and crop-loss relationship of the stem-gall disease of *Coriandrum sativum* caused by *Protomyces macrosporus* Unger.

An infected field was selected near Gwalior where the disease is common. Hundred plants at maturity were harvested at random during the *rabi* 1952-53 and observations on growth (dry weight), disease intensity and yield were recorded. A suitable technique was developed to appraise the disease. Various simple correlation-coefficients have been calculated to bring out the relationship among disease intensity, growth, yield and crop-loss.

The mean loss per plant in the cultivator's field comes to about 15% with a mean total disease intensity of 23%. Regression value (b) for loss percentage on total disease intensity comes to 0.89 *i.e.*, a 10% increase in total disease intensity results in 8.9% loss in expected yield.

I am highly indebted to Professor S. Sinha and Dr. I. M. Rao for giving valuable suggestions and help during the progress of the work ; grateful thanks are due to the Ministry of Education, Government of India, for the award of a research scholarship.

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*Original not seen; source from Chester.

NOTES ON SOME FUNGI FROM SOUTH INDIA—III

T. S. RAMAKRISHNAN AND N. V. SUNDARAM

(Accepted for publication, August 6, 1954)

Synchytrium atylosiae (Petch) Gaumann

Gaumann, E., *Ann. Mycol., 25*, 124, 1927.

Galls are formed on leaves, stem and pods. When young, these are dome shaped and orange yellow in colour occurring singly or in clusters. With age many of them rupture and become cupulate. The sporangial masses are globose, embedded in the gall and measure 168—364 × 140—322μ. One or more masses occur in each gall. These are orange coloured and made up of numerous sporangia. Each sporangium is thin walled, globose or angular, measuring 19μ (15—22 × 12—22) in diam. and with orange yellow contents.

On living leaves, stem and pods of *Rhynchosia minima* DC. (Papilionatae), Ganguvarpatty (Madurai District), 22-1-'54, N. V Sundaram.

Plasmopara vernoniae-chinensis Saw.

Syn : *P. halstedii* (Farl.) Berl. et de Toni.

Sawada, K., *Agri. Expt. Stn. Govt.* of *Formosa, Spec. Bull.* 19, 98, 1919.

Campbell, L., *Mycologia, 24*, 330 – 333, 1932.

Widespread infection of *Vernonia cinerea* was evident during November-December, 1953, at Coimbatore. Yellowish indefinite spots appeared on the upper surface of the leaves. On the lower surface whitish downy growths made up of the conidiophores and conidia of the fungus were observed. The hyphae were inter-cellular and produced button shaped haustoria. The conidiophores emerged through the stomata and were branched repeatedly. The base of the main conidiophore was slightly swollen. The length of the conidiophore varied from 300 to 1050μ. The sterigmata measured 6—15μ. The conidia were hyaline and elliptic, thin walled measuring 14 × 12μ (12 – 19 × 9 – 19). In many of the conidia a distinct papilla was evident.

On living leaves of *Vernonia cinerea* Less. (Compositae), Coimbatore, 12-11-53, N. V. Sundaram.

The species of *Plasmopara* recorded on the Compositae have been included under *P. halstedii.* Sawada described *P. vernoniae-chinensis* on *Vernonia chinense* from Formosa. He has considered *P. halstedii* as a synonym. Later workers have expressed the necessity for dividing *P. halstedii* into several species and two species were created by Campbell on *Eupatorium areolatum* DC. and *Galinsoga*

parviflora Cav. respectively. The fungus under study is however included under *P. vernoniae-chinensis* which it resembles.

Inoculations were conducted utilising fresh conidia from naturally infected leaves collected at about 6 A.M., on healthy seedlings of the host. After inoculation the plants were covered with alkathene bags. Signs of infection were evident on the 9th day and the conidiophores were formed on the 11th day. The fungus did not pass on to *Vitis vinifera* or *Peristrophe bicalyculata*. These exhibited infection by *P. viticola* and *P. wildemaniana* respectively at that time of the year in the same locality.

Phyllactinia corylea (Pers.) Karst.

Salmon, E. S., *Mem. Torrey Bot. Club*, 9, 224—236, 1900.

This is the powdery mildew infecting mulberry in many parts of this State. The conidial phase is prevalent almost throughout the year in Coimbatore and Nilgiri districts forming white powdery growths on the lower surface of the leaves. The corresponding upper surface exhibits a pale yellowish green discolouration. Heavily mildewed leaves turn yellow and are shed. The mildew is partly endophytic and partly ectophytic.

The incidence of the disease was very high in some years at Coonoor on the plantations of mulberry raised at the Government silk farm. The supply of healthy leaves for the feeding of silk worms was extremely difficult, especially in the months of September to January. The perfect stage was rare. In some years the perithecia were recorded at Coonoor during the months of October-January.

For the first time the occurrence of perithecia was observed at Coimbatore in December 1953 and January 1954. These appear as minute reddish to dark brown round bodies $135-290\mu$ in diameter each provided with an equatorial ring of hyaline, stiff, acicular appendages with bulbous bases. These appendages make hygroscopic movements and are helpful in the dispersal of the perithecia. Each perithecium contains several asci measuring $61-103 \times 22-39\mu$ and each ascus has two oblong, light yellow ascospores. They measure $33 \times 19\mu$ $(30-42 \times 15-22)$. The perithecia are embeded in the whitish fungal growth on the lower surface of the leaves.

The control of this mildew is not easily achieved. Where the plant is grown for the supply of leaves to rear silk worms, application of fungicides like Bordeaux mixture or lime sulphur on foliage is not desirable as feeding the silk worm with leaves coated with fungicides may be harmful. On the silk farm at Coonoor several experiments were carried out for the control of this mildew. The bushes were pruned down to six inches from the soil level and the stumps were drenched with Bordeaux mixture or lime sulphur or dusted with powdered sulphur. The new flushes remained free from infection only for a very short period of a month after which infection began to spread. At the end of 3 months no significant difference could be made out between the treated and the unsprayed bushes. This must be attributed to the presence of infected plants in the neighbouring

areas and also to the favourable environment prevalent in the tract. However the results indicated that these measures were not very useful on the Nilgiris. Observations made in later years showed that variations existed in the different varieties of mulberry in regard to their susceptibility to mildew. Wherever mulberry is grown for rearing silk worms selection of such varieties of mulberry as exhibit low infection by mildew is desirable for propagation, as preventive treatment for the control of mildew by the use of fungicides cannot be taken up without affecting the health of the silk worms.

Phyllachora dolichogena (B. and Br.) Sacc.

Syn. *Dothidea dolichogena* B. & Br.

Saccardo P. A., *Syll. Fung. 2*, 601, 1883.

Ascomata amphigenous, black, shining, conical to hemispherical, clypeate, of varying sizes, loculate, 184—304 μ broad and 168—224 μ high, sometimes arranged by the side of the veins, one or more loculate, occupying over three fourths of the thickness of the leaf. Asci numerous, hyaline, more or less cylindrical, rounded apex, 8-spored, paraphysate, paraphyses hyaline, gelatinising, 71×10 μ ($52-99 \times 9-12$); ascospores subglobose, hyaline, monostichous, 9 μ (6—12) in diam.

On living leaflets of *Dolichos lab-lab* L. (Papilionatae), Wynaad (Malabar), 18-12-53, P.K. Ramachandran.

The leaf is studded with numerous ascostromata, This species has previously been recorded from Ceylon but no record of this fungus in India is available. The size and shape of the ascospores of the fungus under study are similar to those recorded for the fungus in Ceylon. Owing to the close similarity the fungus is identified as *P. dolichogena*.

Puccinia amphilophidis Doidge

Doidge, E.M., *Bothalia, 3*, 496, 1939.

On living leaves of *Amphilophis pertusa* Stapf (Gramineae), Coimbatore, 10-10-53, N.V. Sundaram.

Severe infection of *Amphilophis pertusa* by this rust was observed at Coimbatore from October to February. Uredia and telia were mostly hypophyllous, minute and erumpent. Urediospores were oval to subglobose, echinulate, measuring 28×22 μ ($22-34 \times 19-25$), with 4—6 equatorial germ pores. Numerous light brown capitate paraphyses with the wall thickened near the apex were found mixed with the spores in the sori. They measured $40-84 \times 12-25$ μ. Telia were found mixed with the uredia and were darker coloured. The teliospores were chestnut brown, 34×25 μ ($25-40 \times 22-28$), with rounded apex and long brown pedicels measuring up to 61 μ. The insertions of the stalk exhibited variation i.e. the septum of the teliospore was either vertical, horizontal or oblique. Fresh teliospores did not germinate. Two rusts viz., *P.duthiae* Ellis and Tracy and *P. amphilophidis* have been recorded on *A. pertusa*. A critical examination revealed that the rust under study closely resembled the latter. It is possible that the two species are identical.

Puccinia substriata Ell. et Barth.

Sydow, P. & H., *Monogr. Ured. 1*, 774-775, 1904.

Uredia amphigenous, numerous, scattered, crowded or sparse, erumpent, brown; urediospores subglobose or obovate, light brown, pedicellate, minutely verruculose (visible only under the oil immersion lens), $31 \times 25\ \mu$ ($28-34 \times 22-31$), with 4 subequatorial germpores; telia mixed with the uredia, long covered by the epidermis, later erumpent, dark, amphigenous; teliospores 2-celled, of varying shapes, elliptic, oblong or clavate with rounded or flattened apices, slightly constricted at the septum, light brown to reddish brown, $40 \times 22\ \mu$ ($28-47 \times 19-28$); mesospores present, $25-37 \times 12-25\ \mu$, obovate, same colour as the teliospores, pedicellate, pedicel short and coloured; clavate paraphyses are present on the margin of the telia.

On living leaves of *Paspalum scrobiculatum* L. (Gramineae), Coimbatore, 12-12-53, T.S. Ramakrishanan and N.V. Sundaram.

A number of species of *Puccinia* have been recorded on this host genus. But the rust under study resembles *P. substriata* in all its characters and is identified as such.

Cercospora galactiae Ell. & Ev.

Ellis, J. B. & Everheart, B. M., *Bull. Torrey Bot. Club*, 438, 1895. Saccardo, P.A., *Syll. Fung.* 14, 1190, 1899.

There are no distinct spots but olive coloured indefinite areas bearing clusters of conidiophores are present on both sides of the leaf but more on the lower surface. A pseudostromatous mass is formed under the epidermis from which the conodiophores originate. The conidiophores are brown, septate, branched and geniculate. They measure $47-186 \times 3-6\ \mu$. The conidia are hyaline, tapering towards the base and the apex, 3–5 septate, $36-93 \times 3-6\ \mu$.

On living leaflets of *Galactia tenuiflora* W. & A. (Papilionatae), Kallar (Coimbatore), 14-2-54, N.V. Sundaram.

Two species of *Cercospora* namely *C. galactiae* and *C. flagellifera* Atk. (Saccardo, P.A., *Syll. Fung. 10*, 622) have been recorded on this host genus. The fungus under study resembles the former and is identified as such.

Exosporium arecae (B. & Br.) Petch

Syn: *Helminthosporium arecae* B. & Br.

Petch, T., *Ann. Roy. Bot. Garden, Peradenya, 10*, 173—174, 1927.

This fungus forms black pulvinate growths on the lower surface of areca leaves. The incidence of infection is high during the rainy months and scanty in the dry summer months. The pulvinate stromata project out of the stomata. From the stromata superficial hyphae radiate over the surface forming a net work. From the

superficial hyphae erect thick walled conidiophores 160—500 μ in length and 9—12 μ in width are formed in large numbers. The conidia are obclavate or broadly flask shaped with a tapering apex and are dark brown in colour. They are 4-5 celled and measure 68×19 μ ($58-102 \times 15-22$). Both conidiophores and conidia have minutely verruculose surfaces. The tissues of the leaf are fully permeated by inter and intracellular, hyaline, septate hyphae. Some of the hyphae collect under the stoma and develop dark pseudoparenchymatous stromata projecting through the stoma.

On living leaves of *Areca catechu* L. (Palmaceae), Vittal (South Kanara), 28-8-53, T. S. Ramakrishnan.

The fungus is truly parasitic on the leaves of areca. The spores germinate readily in 6 hours producing one or more germ tubes either terminally or laterally. Inoculations carried out with the germinating spores resulted in positive infection in the course of 3-4 weeks. In the initial stages isolated growths were observed. Each one consisted of a pulvinate, darkcentre from which radiating coloured hyphae developed. The spread of infection was limited under conditions prevalent in Coimbatore but in Vittal (South Kanara) infection spread quickly over the major portion of the lower surface. Humidity appears to be the chief factor responsible for this.

Macrophoma celastrina Died.

Sydow, H. & P. and Butler, E. J., *Ann. Mycol. 14*, 186, 1916.

Brown amphigenous circular or irregular spots occur in varying numbers on the leaves. Each spot has a dark margin as distinct from the rest of the spot. The pycnidia are epiphyllous and are scattered or occur in concentric rings as dark, minute raised dotts. They are innate, erumpent, ostiolate, measuring 98—154 μ in breadth and 84—100 μ in height. The pycnidiospores are hyaline, oval or oblong and measure 12×9 μ ($9-12 \times 7-11$).

On living leaves of *Celastrus paniculata* Willd. (Celastracae), Kallar (Coimbatore), 20-2-54, N. V. Sundaram.

Ramularia gymnematis sp. nov.

Spots indefinite, yellowish on the upper surface and with white growth on the lower surface; internal hyphae intercellular, hyaline, emerging through the stoma producing diffused growth on the surface; conidiophores produced on the surface mycelium, branched, hyaline, $16-31 \times 4-6$ μ, rarely septate; conidia slender, elongated, hyaline, 2-3 septate, measuring 37×3.5 μ ($28-47 \times 3-5$), broader at the base and gradually tapering towards the apex.

Maculae indefinitae, luteolae in superiore pagina, accrescentia alba ornatae in inferiore pagina: hyphae internae intercelulares, hyalinae, emergentes per stomata atque diffuse crecentes per superficiem foliorum; conidiophori product in mycelio superficiali, ramosi, hyalini, $16-31 \times 4-6$ μ, raro septati; conidia tenuia, elongata, hyalina, bis vel ter septata, magnit. 37×3.5 μ ($28-47 \times 3-5$), latiora ad basim, atque gradatim fastigata ad apicem.

On living leaves of *Gymnema sylvestre* R. Br. (Asclepiadaceae), Kallar (Coimbatore), 20-2-54, N. V. Sundaram.

The infected areas appear as indefinite yellowish patches on the upper surface of the leaves. On the corresponding lower surface white fungal growth is evident. The hyphae develop intercellularly in the mesopyll. Later one or more hyphae come out through the stoma and spread on the surface. The conidiophores are formed on the external mycelium.

Septoria apii-graveolentis Dorogin

Soccardo, P. A., *25*, 454, 1931.

Butler, E. J. & Jones, S. G., Plant Pathology, 630-633, 1949.

Spots amphigenous varying in size, indefinite or sometimes definite, brown or brownish green; pycnidia subepidermal, amphigenous, minute, crowded, black, ostiolate, globose, 60 -150 μ in diameter; pycnidiospores hyaline, slender flexuous, $25-53 \times 1.5$ μ, most of the spores having 3 septa.

On living leaves of *Apium graveolens* L. (Umbelliferae), Ootacamund, 14-3-54, T. S. Ramakrishnan.

The infected leaves are conspicuous by their discolouration. Numerous spots occur on the leaves which turn yellowish brown. The spots are clearly defined in some cases but are mainly indefinite. The pycnidia appear as black dots and are formed even outside the spotted region. They are visible on both sides. The septation of the spores is not clearly defined but the majority of the spores reveal the presence of 3 septa.

Our thanks are due to Rev. Dr. H. Santapau, St. Xavier's College, Bombay for the latin diagnosis and to the Systematic Botanist and Professor of Botany, Lawley Road Post, for identifying some of the host plants. We are grateful to Dr. B. L. Chona for kindly supplying information on *Plasmopara vernoniae-chinensis.*

Mycological Laboratory
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LIST OF ILLUSTRATIONS.

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Fig. 2. *Plasmopara vernoniae-chinensis :* Portion of a conidiophore showing the branching and sterigmata, base of the conidiophore and conidia.

Fig. 3. *Phyllachora dolichogena :* An infected leaflet, section through a stroma showing the locules (semidiagrammatic), ascus and ascospores.

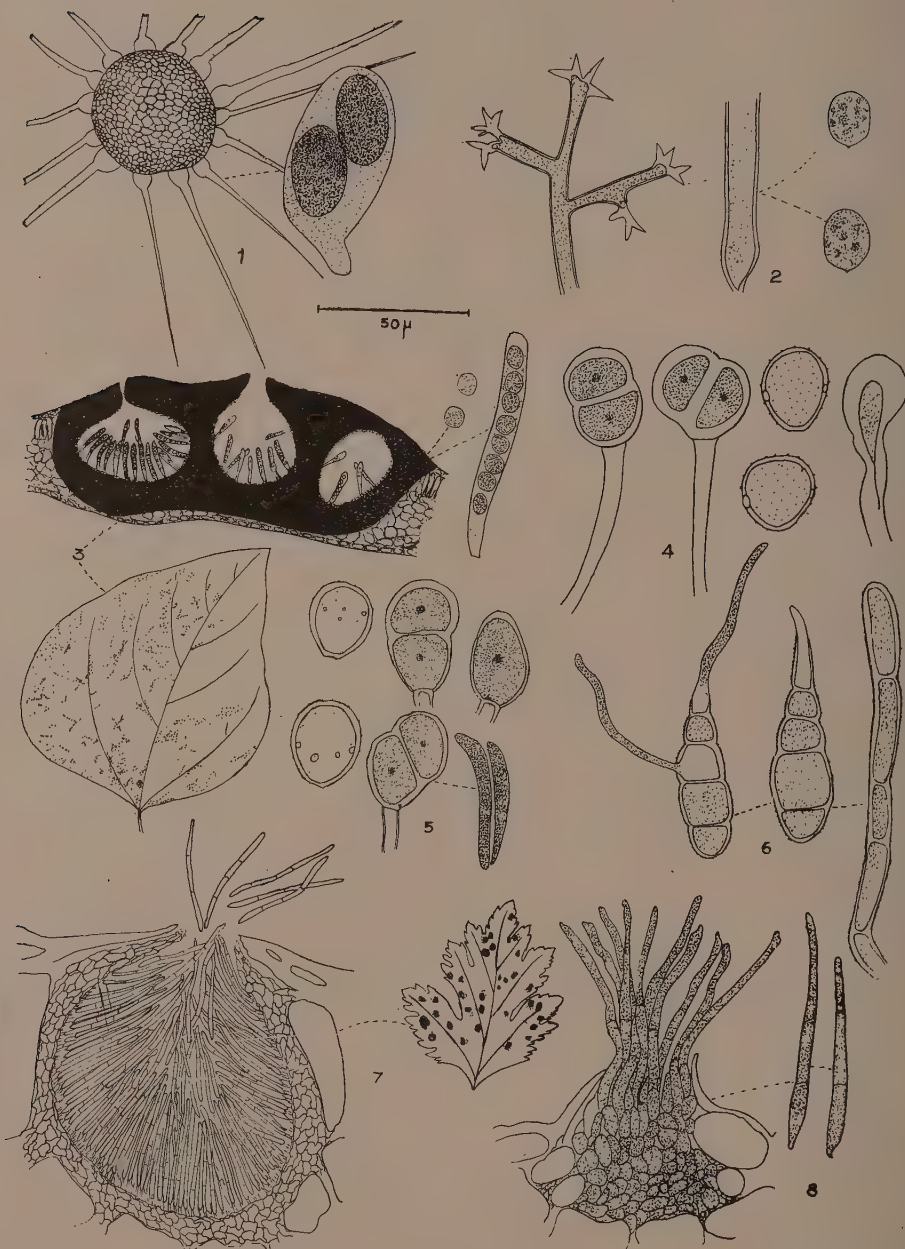
Fig. 4. *Puccinia amphilophidis :* Teliospores, urediospores and paraphysis.

Fig. 5. *Puccinia substriata :* Urediospores, teliospores, mesospore and paraphyses.

Fig. 6. *Exosporium arecae :* Germinating conidium, conidium and conidiophore.

Fig. 7. *Septoria apii-graveolentis :* Section of pycnidium and the infected leaf showing the spots.

Fig. 8. *Cercospora galactiae* : Section showing the stroma and conidiophores and conidia.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PHYTOPATHOLOGICAL NOTES

Two additions to the list of Indian Ascomycetes. S. B. Chattopadhyay. In this paper, a short description is given of the two fungi, belonging to Ascomycetes, which are new records in India. The culture in one case and the specimen in other have been kept in the Mycology Section, State Agricultural Research Institute, Tollygunge, Calcutta and have also been deposited in the Division of Mycology and Pathology, Indian Agricultural Research Institute, New Delhi.

1. LEPTOSPHAERIA *oryzina* SACCARDO in Notae, Mycol. XXIII, in Att. Accad. Sci. ven.—trent.—istr., X, p. 67, 1917.

Lit.	Saccardo, syll. Fung, XXIV. p. 996, 1928.
Habitat.	On dead lemma and palea of paddy.
Locality.	In Mathabanga (Cooch-behar), Memari (Burdwan) and State Agricultural Farm, Chinsurah, West Bengal, Collected by S. B. Chattopadhyay in December, 1952.
Distribution :	Los Banos, Phillipines, Saccardo, loc. cit.

DESCRIPTION

Perithecia—On the dead lemma and palea of sterile spikelets, small, dot-like, black, superficial, globose to subglobose, varying in

Fig.1.

Leptosphaeria oryzina Saccardo.

a. Asci with 8 ascospores in each ascus.
b. Ascospores.

diameter, from 100–160μ averaging 120μ in diameter, wall pseudoparenchymatous, membranous, not prominently papillate ; asci-closely packed inside the perithecia, without paraphyses, clavate, somewhat fusoid, hyaline, thin-walled, rounded at the apex, almost sessile, 40.7–59.9 $\times$ 7.4–9.3μ, averaging 48 $\times$ 8μ, 8-spored, ascospores-biseriate, fusoid, slightly curved, brown, 3-septate, obtuse to rounded at both ends, 16.7–19.3 $\times$ 2.8–4.4μ averaging 17.6 $\times$ 3.8μ.

(Specimen No. 483 of the Herbarium of Mycology Section, State Agricultural Research Institute, Tollygunge, Calcutta.

No exsiccati material was available either from Commonwealth Mycological Institute, Kew, Surrey—or from Saccardo's collection at Padua, hence no comparison could be made with either original specimen or any exsiccati set.

2. THIELAVIA TERRICOLA (GILMAN AND ABBOT) EMMONS in *Bull. Torrey. Bot. Club.* 57 : 123-126. 1930.

Syn. *Coniothyrium terricola* Gilman and Abbot in *Iowa State College. Jour. Sci.* 1 : 225-344, 1927.

Lit. Ma, R. M.—*Lingnan Sci. Jour. Supp.* 12 : 115-118, 1933.

Morrow, M. B.—*Ecology* 12 : 499-507, 1931.

Gilman and Abbot. loc. cit.

Distribution : China, (Ma loc. cit.) ; U.S.A.—Texas, (Morrow loc. cit.) ; Iowa,—Louisana, (Gilman and Abbot loc. cit.)

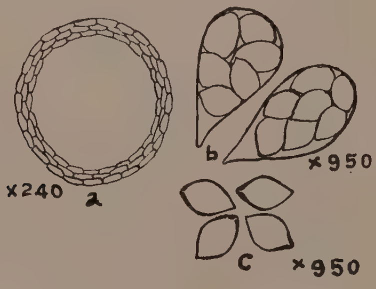


Fig. 2

Thielavia terricola (Gilman & Abbot) Emmons.

a. Cleistothecium.

b. Asci with ascospores (all the 8 ascospores cannot be seen in one focus),

c. Ascospores.

Colonies on maize meal and potato dextrose agar spreading, growing very rapidly with abundant cottony aerial hyphae and submerged hyphae, aerial and submerged hyphae white, narrow in diameter, 1–4μ, after two weeks growth at 22-23°C, the aerial cottony

layer becomes downy or appressed, and may show a very light creamy tinge ; cleistothecia appear as minute light-brown dots on the margins of the cultures first, later on at the centre and then elsewhere ; mature cleistothecia darkbrown to black due to the presence of large number of dark coloured spores inside it, globose, varying in diameter from $70-150\mu$, outer wall of cleistothecium composed of three to four layers of small rectangular cells, dark brown in colour, inner wall of thinwalled, flattened and brown coloured cells ; young cleistothecium packed with asci ; asci-oval to pyriform, not pedicellate, hyaline, thinwalled, measuring $23.4-29.3\times15.6-19.5\mu$, averaging $24.5\times16.5\mu$, deliquescing within the cleistothecium releasing the spores inside it, 8-spored ; ascospores irregularly arranged, one celled, elliptical to broadly fusiform, slightly pointed at the two ends, with one germ pore at one end and wall thickened at the ends opposite the germ pore, young ascospores within the ascus hyaline, when mature dark olivceous to brown, measuring $9.2-10.9\times6.6-8.2\mu$, averaging $9.9\times7.3\mu$.

Isolated from top soils and 3″ level in the paddy fields of State Agricultural Farm, Chinsurah, West Bengal by S. B. Chattopadhay in June, 1950.

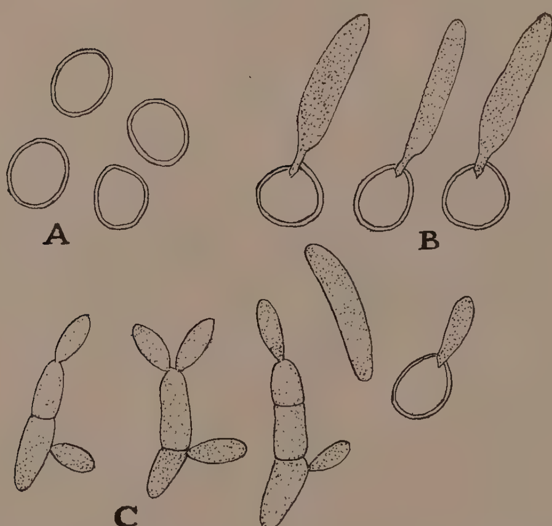
Sincere thanks are due to Dr. M. J. Thirumalachar for helping in identification of the fungus.—State Agricultural Research Institute, Government of West Bengal, 230 Netaji Subhas Road, Regent Park, Calcutta-40.

Smut on Rynchospora corymbosa Dom. T. S. Ramakrishnan. A smut was prevalent on *Rynchospora corymbosa* in Wynaad Malabar district, Madras State, during January 1954. The sori were confined to the inflorescence, infecting the ovaries of a number of spikelets. Mixed with the sori were healthy normal nutlets in the same branches of the inflorescence. The sori were cylindrical and covered by a whitish membrane. The false membrane was split open at the apex exposing the black mass of powdery spores. Gradually portions of the membrane flaked off from the tip downwards till the sori dwindled down to a small black mass at the base. When a number of sori broke down in this manner the characteristic appearance of the infected panicles with several dark masses of spores intersporsed with other healthy branches was produced.

The description of the smut is as given below :—

Sori ovaricolous, whitish when young, oval to cylindrical, 2 - 12 mm. in length and 2 - 3 mm in width, covered by a false membrane of fungal tissue, columella restricted to a minute knob at the base, formed of host tissue. Spore mass black, powdery above but persisting as black mass at the base of primary and secondary branches of the inflorescence; spores easily separating, subglobose to elliptic, buffy citrine to orange citrine, $13\times12\ \mu$ $(11-17\times11-16)$, wall about $1\ \mu$ in thickness, smooth, contents present a reticulate appearance.

1. A photograph of a branch of the panicle showing sori.



2. (A) Spores, (B) formation of promycelium and (C) separated promycelia producing sporidia (X 700).

It has been reported by Clinton (1904) that the germination of the spores of *Cintractia* or *Sorosporium* infecting *Rhynchospora* had not been studied or reported. Mundkur and Thirumalachar (1952) however have stated that germination in *Cintractia* is by means of a "septate promycelium sometimes branched forming terminal and lateral sporidia". Since a fresh collection of smut was available germination studies were initiated. The spores were floated in drops of tap water and the slides were incubated in moist chambers at 80 - 82°F. Germination commenced in 4 hours with the protrusion of a hyaline promycelium. Only one was formed for each spore. In six to eight hours, the promycelium assumed a cylindrical shape, straight or slightly curved and attached to the spore by a narrow stalk. In 12 hours most of the promycelia separated from the stalks and floated as independent structures with rounded or obtuse ends. Septation was indistinct at this stage. A couple of hours later, lateral and terminal, elliptic or spindle shaped sporidia were developed. Septation was distinct at this stage and one to three septa were present in each promycelium.

Several smuts have been recorded on the genus *Rhynchospora*. The smut under study resembles *Cintractia spicularum* Racib. according to the discription by Ling (1950). Mundkur and Thirumalachar (1952) who have included this smut in their ustilaginales of India state that it has been recorded on the ovaries of *Rhynchospora corymbosa* in India. However, the specimens of the same examined by them in the herbarium of the Botanic gardens, Calcutta were without any smut. The external appearance of the entire sorus, the possession of a well developed false membrane covering the sorus, and the powdery nature of the major part of the spore mass suggest that the smut has greater affinity to *Sphacelotheca* and may be transferred to this genus. Mycology Section, Agricultural Institute and College, Coimbatore.

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Infection caused by the oospores of **Sclerospora sorghi** (*Kulk.*) *Weston and Uppal on* **Sorghum vulgare** *Pers.* D. Suryanarayana. *Sclerospora sorghi* (Kulk.) Weston and Uppal causes the downy mildew of *jowar* (*Sorghum vulgare* Pers.). Its successful infection was secured by Weston and Uppal (1932) and Uppal and Desai (1932) but the mode of infection as also the recurrence of the disease under field conditions, which do not appear to have received adequate attention have now been studied and are reported here.

Oospore material of *Sclerospora sorghi* obtained from Poona in August, 1945, was stored until the time of inoculation inside the

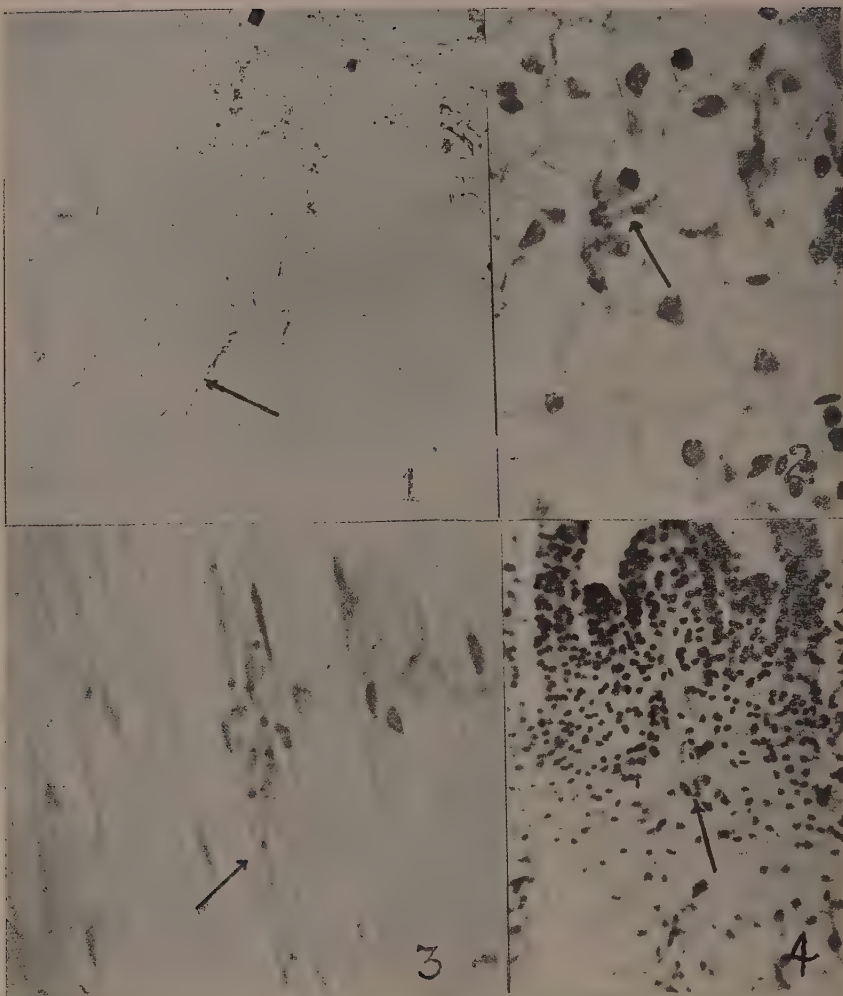

Fig. 1. A hypha of the adventitious root of the seedling of *jowar* X 75.
Fig. 2. Intercellular hyphae in the pith of the infected plant of *jowar*. X 570.
Fig. 3. A magnified hypha higher up in the stem. X 570.
Fig. 4. A hypha near the growing point of the stem of the seedling. X 230.

laboratory and also buried in pots in the field. Seedling of *jowar* of a local variety were raised during October, 1946, in pots containing sterilized soil inoculated with oospore material which had been stored in the laboratory and also with that kept in the field.

Infected material exposed to the field conditions for about 15 months gave 31% infection while no infection occurred in the series where the material stored in the laboratory was used as inoculum. The factors responsible for such activity of the material exposed to the field conditions require to be investigated. Oospores of *Sclerospora graminicola* (Sacc.) Schroet, were found to behave in a similar way in relation to *bajra* (*Pennisetum typhoides* Stapf and Hubbard) after having been exposed to field conditions (Suryanarayana, 1953). The maximum temperature recorded during the period of storage of the material was 115°F. in the shade.

In order to study the mode of infection, seedlings were removed periodically from the two infection series, washed, fixed in Rawlin's (1933) F.A.A. (Formula I), stained with iron alum hematoxylin and examined for infection. Stout, aseptate hyphae with conspicuous nuclei characteristic of the genus *Sclerospora*, were observed in the adventitious roots and basal, middle and apical portions of the stem of some of the seedlings. This shows that oospore infection is initiated in the underground parts wherefrom it spreads upwards and is systemic (Plate I, figs. 1-4) as in the case of *bajra* (1. c.).

The writer is grateful to late Dr. K.C. Mehta of Agra College, Agra, under whose guidance this work was done and to Dr. S. Sinha of the same college for critically going through the manuscript. Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi-12.

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The occurrence of **Helicostilbe simplex** *Petch on* **Daphniphyllum neilgherrense** *Rosenth.* M. Kandaswamy and C. L. Subramanian. *Daphniphyllum neilgherrense* Rosenth. is a medium—sized ever-green tree growing in the forests of Nilgiris and Pulneys at altitudes of above 5000 feet. During the month of March, 1954, the leaves of the trees were found to be affected by a fungus which produced small, black, capitate structures on both the surfaces, but mostly on the lower surface. These were found to be the synnemata of a member of Stilbellaceae. This fungus was observed in Kotagiri (Nilgiris) and Kodaikanal. A description of the fungus is given below :—

The synnemata originate from well developed sub-epidermal, often deep seated stromata and measure 0.5 mm. to 1.5 mm. in length and 25 to 60μ in breadth. The internal mycelium consists of inter-and intracellular, septate hyphae which are hyaline when young and develop a buffy brown colour with age. Branched, septate conidio-phores are found at the terminal portions of the synnemata. The conidia are terminal, 3 to 7 septate uncinate and cameo brown to Rood's brown in colour (Ridgeway 1912). The longer arm of the conidia measure $18-30\times4-6\mu$ while the shorter arm $9-16\times4-6\mu$ and is either coiled or bent over the longer arm.

Petch (1922) has reported the occurrence *Helicostilbe simplex* Petch on the leaves of *Daphniphyllum glaucessens* Bl. from Ceylon. But there does not appear to be any record of this fungus on this host genus from India. The fungus under study closely resembles that described by Petch excepting for slight variations in the measurements and therefore is identified as *Helicostilbe simplex* Petch.

Our thanks are due to Sri T. S. Ramakrishnan, M.A. F.A.Sc., Government Mycologist and Professor of Plant Pathology for his valuable suggestions in the preparation of this note. Mycology Section, Agricultural College, Combatote.

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Downy Mildew of *Rumex vesicarius* L. in Bombay. M. K. Patel and V. P. Bhide. *R. vesicarius*, locally known as *Chuka*, is a popular leafy vegetable grown throughout the year in Bombay, Deccan, although its cultivation is largely restricted to the monsoon months. The crop usually suffers from downy mildew caused by *Peronospora rumicis* Corda from August to December resulting in decreased yields. The symtoms of the disease are similar to those of any other downy mildew in that the leaves are covered on the underside by a downy growth of the fungus with chlorotic patches on the upper side. Affected leaves turn brown and eventually die.

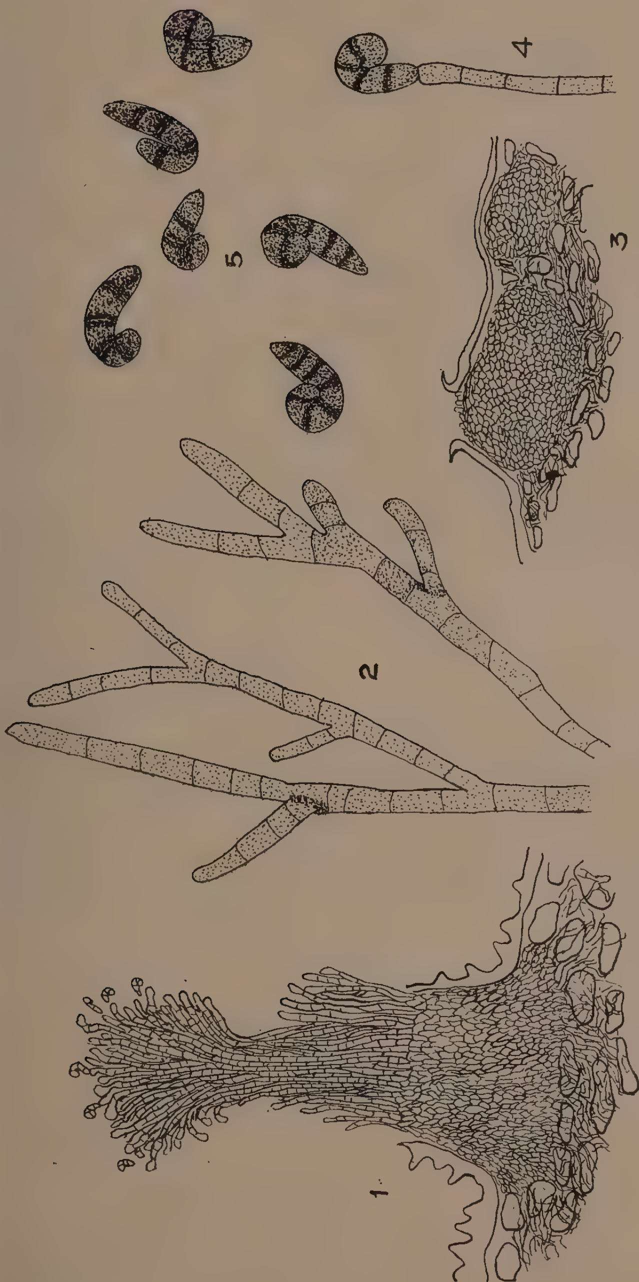

Fig. 1. A section through the infected portion of the leaf showing a synnema with conidiophores and conidia (semidiagramatic).

Fig. 2. Conidiophores. X 500.

Fig. 3. A section of young fructification (semidiagramatic).

Fig. 4. A branch of the conidiophore bearing a conidium X 500,

Fig. 5. Conidia X 500.

The pathogenicity of the fungus was easily proved by inoculating *Rumex* plants with conidia collected from diseased specimens in the field. The plants were kept in a moist chamber for 24 hours before and after inoculation, which was done by spraying the plants with a suspension of conidia in water. Typical symptoms of mildew appeared one week after inoculation. Plants were susceptible at all stages of growth. Besides *Rumex vesicarius*, the following species of *Rumex* were also inoculated but none proved susceptible: *R. maritimus*, *R. nepalensis*, *R. conglomeratus*, *R. papilio*, *R. arifolius*, *R. hydrolapathum*, *R. patientia*, *R. neomexicana*, *R. hymenosepalus*, *R. obtusifolius* and *R. crispus*. It would thus seem that the fungus is restricted to its own host only, namely, *Rumex vesicarius*. The germination of the conidia when studied at various temperatures in hanging drop preparartions showed no germination at 0°C. and at 30°., the most optimum temperature being 19°C. (76% germination) and the minimum and maximum were 5°C. and 25°C. respectively. More than 50% germination occurred between 12°C. and 22°C. The conidia measure $23-33 \times 17-21$ microns, whereas the conidiophores measure anything from 100 to 500 microns. The fungus does not produce oospores under Bombay condition. The measurements of the conidia show that the fungus is indistinguishable from *Peronospora rumicis* Corda the conidia of which measure $26-33 \times 16-20$ microns (Saccardo ; Sylloge Fungorum, VII (1) : 262).. College of Agriculture, Poona 5.

Guava Disease in Pushkar Valley and its Control.—R. S. Vasudeva and S. P. Raychaudhuri. Guava (*Psidium guajava L.*) is widely cultivated in the Pushkar area in Ajmer and there are about 15,000 guava trees in 175 orchards. A serious disease of guava plants was reported in 1949. In fact, the cultivators were abandoning guava cultivation in Pushkar area due to the seriousness of the disease. Annually two crops are obtained, one in summer and the other in the winter season and the average yield per healthy tree per year is about 5 maunds. The cost of guava is about Rs. 9/- per maund, so that the loss due to the disease per plant is about Rs. 45/- per year. With an average holding of 100 plants the loss to a grower works out of about Rs. 4500/- per annum which obviously is extremely heavy when individuals are concerned. The loss to the growers in the area would come to about Rs. 6.5 lakhs annually.

The disease is characterised by interveinal leaf chlorosis, reduction in leaf size, suppression of growth and die back of leaders (Fig. 1a, 1b). The leaves are somewhat leathery and may show green vein banding (Fig. 2). The diseased shoots bear few or no flowers and the fruits if any dry up and are cracked (Fig. 3). In fully affected plants no fruits are formed resulting in total loss to the cultivators. The symptoms indicated that the disease might be of virus origin although the possibility of it being a deficiency disease could not be ruled out. The disease is, however, restricted to Pushkar area and the guava orchards in the neighbouring areas, of Panchkund Forest Nursery, Hatungi, Ajmer town, etc. are so far free from the disorder.

Fig. 1-a.—A diseased guava plant.

Fig. 1-b.—A diseased shoot of guava.

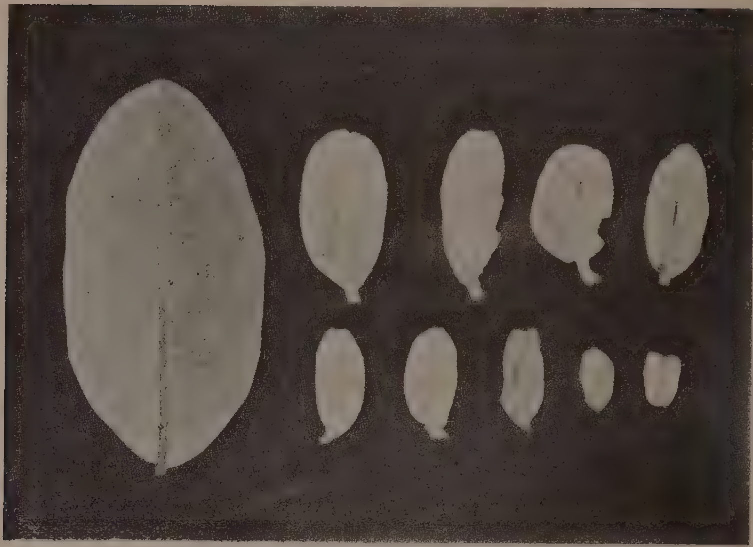

Fig. 2—*Extreme left*—a healthy leaf of guava. Other leaves are diseased.

Fig. 3—Cracked fruits borne by a diseased branch.

Fig. 4. *Right*—a healthy shoot of guava. *Middle*—a diseased shoot *Left*—a diseased shoot which had been sprayed with zinc sulphate. New growth is healthy and is bearing fruits.

During 1949-53 about 100 grafts were made using healthy guava plants raised from seeds in the insect-proof glass house as the stock and diseased guava shoots as the scion, but all these tests gave negative results and the disease could not be transmitted. Also, 20 small diseased guava plants brought from Pushkar area on different occasions and planted in Delhi soil appeared to have recovered from the disease. In addition, 3 diseased plants brought from Pushkar, planted in Delhi soil and inarched with healthy guava plants in the glass house, were also found to recover from the disease. These observations, coupled with the fact that no bacterium or fungus could be isolated from the diseased shoots and leaves, indicated the possibility of the disease being due to some nutritional deficiency which is known to cause similar disorders of fruit trees.

Experiments were undertaken in Ganera village in Pushkar Valley in order to determine whether or not foliage sprays of zinc sulphate, managnese sulphate or ferrous sulphate mixed with hydrated lime, in water, or Bordeaux mixture could be employed to rectify the disorder. During July-September, 1954, guava trees in four different orchards were sprayed and in one orchard half of the treated trees under each treatment were sprayed for the second time also to see if two applications were more beneficial than one. In all cases zinc sulphate proved to be effective and the branches which were diseased put out normal healthy leaves and have begun to flower. In fact fruits have already set in a fairly large number of previously diseased shoots (Fig. 4). The young diseased plants about 2-3 years old which had been sprayed in another orchard seem to compare favourably with normal healthy plants. The second spraying appeared to be more beneficial. The foliage spray of zinc sulphate employed consisted of zinc sulphate—1.0 lb., hydrated lime—0.7 lb., water—16 gal.

Zinc deficiency is known to cause similar diseases in pear, peach and citrus trees* where more or less similar type of symptoms appear on diseased trees. In all these cases leaf spray of zinc sulphate with hydrated lime, in water at various doses has been found to give beneficial effects. Further work on the disease is, however, in progress.

Thanks are due to Mr. T. K. Nariani of this Division for assisting in the earlier stage of experimental work and to Mr. H. C. Joshi, Plant Protection Assistant of Ajmer for help in the spraying operations.—Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi.

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SEVENTH ANNUAL GENERAL MEETING OF THE INDIAN PHYTOPATHOLOGICAL SOCIETY HELD AT HYDERABAD ON JANUARY 3, 1954

Presidential Address :

R. S. VASUDEVA

I am thankful to the Indian Phytopathological Society for asking me to preside over the deliberations of the Society. Plant Pathology occupies a prominent position in the development of agriculture in this country. Economic stability and prosperity of our newly constituted mother-land are closely linked up with scientific growth and development of agriculture and we the Plant Pathologists of this country have to play an important role in the work connected with it. The crops in this country must be protected from damage in all possible ways to conserve food and severe losses can be averted by timely application of control measures.

Yields of crops in India are lower than other countries even under normal conditions but further depressed by diseases. It is generally believed that the yields per acre in India can be pushed up by about 10 per cent by preventing losses due to diseases. I wish in this connection to discuss the present position with regard to wheat rusts in India, which are responsible for destruction of a considerable portion of our crops. The subject is fascinating to students of plant pathology and offers a wide field for varied types of investigations including problems both fundamental and of direct application.

Wheat in India suffers from all the three rusts *i. e. P. graminis tritici* (Pers.) Eriks. & Henn., *P. triticina* Eriks. and *P. glumarum* (Schm.) Eriks. & Henn. Black and yellow rusts are also common on barley but the dwarf rust of barley (*P. simplex*) is rather rare. Of the three rusts yellow rust (*P. glumarum*) is limited in its distribution being restricted to the Northern parts of the country including the Indo-Gangetic plain though it is not altogether absent from South India. No reliable figures for the overall loss on this account are available but it has been experimentally determined that the loss in grain-weight may be anything between 10 to 50 per cent depending on the time and intensity of attack and the wheat variety concerned. In the Indian Union the annual loss in wheat due to rust damage has been estimated at Rs. 49 millions but in years of epidemic as in 1947 the rust may be responsible for more serious losses in certain areas.

In the Indo-Gangetic plain which is the main wheat growing tract, the crop is sown in October to November and harvested in March and April. Yellow rust generally appears early in January followed by brown and black rusts in February or March depending on weather. In places that are situated near the foot hills, the rust

outbreak takes place much earlier, *e.g.*, at Pusa, in Bihar, the rusts have been noticed on the crop as early as the 15th of December. From the time of harvest in April till the month of October, there is no host in the plains on which these rusts could live and the summer heat is so intense that the uredospores cannot remain viable for the period of 5-6 months. It might be stated here that over the greater part of this tract temperature in shade exceeds 110°F. for several days. It is obvious, therefore, that oversummering of rusts in the plains under these circumstances does not appear to be feasible.

In the hills, on the other hand, wheat is sown during September and October and harvested in May and June, depending on the altitude. Consequently, there is a gap of only two to three months when there is no standing wheat crop. On account of congenial climate, uredo stages of all the three rusts have been found to over-summer at different altitudes in the hill (4,000—8,000 ft. a. s. l.) on volunteer plants, stubbles and tillers. These 'out-of-season' plants perpetuate the rust from one season to another and cause early infection of the normal crop which is sown early in winter in the hills. This region can therefore, be independent of the barberries for the perpetuation of the black rust.

In addition to oversummering of the uredial stage on volunteer wheats in the hills, prematurely or early sown fields and crops sown out of season, *i.e.*, during summer, help in the perpetuation of the rust during the critical period and in the early dissemination of the inoculum to the regular winter crop. In Central Nepal the prematurely sown crops planted in August-September at altitudes of 4000 to 5000 ft. have been found to be heavily infected with black rust in the first week of December. Early outbreak of rust has been observed at the foot hills and plains along the Nepal border. The Nepal range is obviously the most dangerous focus for crops in the Indo-Gangetic plains, although in a general way oversummering can take place all along the Himalayan range at suitable altitudes. It was supposed till recently that the main foci of infection in South India were Nilgiri and Palni Hills and that the suspension of wheat cultivation would considerably reduce the ravages of rust in the southern parts of the country. Recent surveys of Western Ghats have, however, modified this view and there are strong indications that oversummering of black and brown rusts is possible at least occassionally in Western Ghats also. In October last, black rust infected self sown plants were found in Panchgani and in the following November wheat crop was found infected by black and brown rusts at many places in that area. In village Godvali (near Panchgani) heavily infected plot was found in the last week of November. The abundance of inoculum of black and brown rusts near about Panchgani, when the crop at lower altitude was practically free of rusts is a strong evidence that oversummering of black and brown rusts is possible in such areas in the Western Ghats where the climatic conditions are more or less similar.

In addition to the cultivation of two crops in the year in Nilgiri and Palni hills, the sowing of wheat in certain tracts with elevation of 3,000 ft. at the foot of these hills in Mysore and Bombay commences

from July and continues till December. The crop sown in July gets infected in September through uredospores that are disseminated from Nilgiri hills with the result that plenty of inoculum is available in the immediate neighbourhood of fields that are sown subsequently. This results in very heavy and early infection, creating epiphytotic conditions in years of favourable rainfall.

Although wild grasses have been reported to be collateral hosts in several countries, in India no definite evidence has so far been obtained of the perpetuation of wheat rusts from one season to the next through the agency of such hosts. The occurrance of *Puccinia graminis tritici* on *Bromus patulus*, *Brachypodium sylvaticum* and *Avena fatua* has been reported but all these grasses are annuals and their growing period in nature coincides with that of wheat. Two other grasses, namely *vulpia myuros* and *Briza minor* are reported to be susceptible to *P. g. avenae* and *P. g. tritici* in the Nilgiri Hills. Seedling inoculations under glasshouse conditions have shown that both of these grasses are susceptible to the black rust of oats but with black rust of wheat (*P. g. tritici*) resistant type of pustules were produced on *V.myuros*. *Briza minor*, however, has not so far been infected. Further tests are however, necessary. A large number of exotic grasses such as *Bromus coloratus*, *B. carinatus*, *B.mollis*, *Hordeum distichon*, *H.murinum*, *H. stenostachya*, *Agropron semicostatum*, *Lolium perenne*, *Hilaria jamesii*, *Aegilops squarrosa* and *A. ventricosa* were found infected by *P. g. tritici* under natural conditions. Besides these a fairly good number of exotic grasses have been shown to be susceptible to wheat rusts. In view of the oversummering of rusts in the hills it is of fundamental importance to test all the imported grasses against Indian physiologic races prior to their release for general cultivation. Also intensive search for collateral hosts is necessary. The rust spores are carried over long distances through the agency of wind currents. The dissemination of uredospores of black rust from the North to the South in the fall and in the reverse direction in the spring in the North American Great Plains is a phenomenon of outstanding importance. There is also a clear evidence of certain amount of interchange of rust between northern Mexico and the United States. In Canada also the uredospores cannot live through the winter and the rust moves north-wards from the United States. With the help of spore traps and exposure of slides in aeroscopes it has been demonstrated in Canada that there is a decrease in the quantity of inoculum and the late arrival of rust at places situated further away to the North. In U. S. S. R. rust spores are blown to the Amur region from North Manchuria with Southern winds. In fact, in the absence of natural barriers, *e. g.* high mountains, vast expense of Oceans or deserts, the mutual inter-change of rust spores through the agency of upper winds between different countries or different parts of the same country is an important factor in the recurrence of rusts.

In India at present the study of dissemination is being carried out with the help of slides exposed at nearly 60 representative stations. The slides are changed twice a week from November onwards till the date of rust appearance. In some stations, particularly in the

foot hills of south India, these slides are exposed for six to eight months. Examination of these slides may give some useful information regarding the probable date when the spores reach a particular place. This method however, has considerable limitations as the uredospores cannot be identified with certainty. For instance, the spores of *P. graminis* may be of any physiological species other than *P. graminis tritici,* as also the dates of appearance of rust recorded by different agencies all over the country cannot always be relied upon.

Himalayas in the North and Indian Ocean in the South normally would be reasonably effective barriers for the air borne dissemination of spores from other countries but to a limited extent dissemination is possible from Afghanistan. With the introduction of air communication, however, the possibility of introduction of new races of rusts from countries situated widely apart cannot be ruled out.

A definite connection between infected barberries and black rust on wheat in U. S. A., Denmark, England and U. S. S. R. has been recorded and the importance of the eradication of barberries in the control of that rust has been recognised. In all those countries where barberries are known to play an active part in the perpetuation of the rust from one season to another, wheat is sown in spring and harvested in the fall. The teleutospores remain dormant during winter, germinate in the spring, infect the barberries and produce the aecial stage. The aeciospores in turn infect the cereals or grasses in the neighbourhood of barberries.

In plains of India which cover more than 95% of the area under wheat there are no barberries, and consequently, the aecial stage does not come into the picture at all. In the hills however, several species of *Berberis* are found. Some of the species such as *B. lycium* have been shown to be susceptible to the sporidia of black rust.

Unlike temperate-zone countries, the teleutospores in India represent the summer-stage in the life-cycle of these rusts. These are formed in the plains in February to April and lose their viability due to high temperatures in summer so that even if disseminated by winds to the hills, cannot infect the barberries. In the hills also teleutospores are formed in May and June, the hottest months in the year. All attempts to germinate teleutospores formed in the lower Simla hills at places situated between 3,000-5,000 ft. have been unsuccessful, but the teleutospores formed at higher altitudes (8,000 and above) remain viable. Taking into consideration the susceptibility of certain indigenous species of *Berberis* e. g. *B. lycium* and also the possibility of occurrence of *B. vulgaris* in the interior of the hills, the chances on infections of *Berberis* at higher altitudes which may account for the appearance of new races, cannot be ruled out. This aspect, therefore, requires careful investigation.

The importance of the study of physiologic races in any breeding programme needs no emphasis and is in progress at Simla Sub-station of the I. A. R. I. on all India basis so that this station serves as the nerve centre of the entire rust work in the country.

For the identification of races only 120-130 samples of black, brown and yellow rusts are being analysed every year but considering the size of the country this number is inadequate and with increased facilities it is hoped that at least three times the samples will be analysed in future. So far 28 races and 2 biotypes *viz.* races 15, 21, 24, 34, 40, 42, 75, 177 122, 194, 15C and 42 B of black rust, 10, 11, 20, 26, 63, 106, 107 and 108 of brown rust and 13, 19, 20, 31, A, D, E, F, G, and H of yellow rust have heen isolated. The last six races of yellow rust have not yet been assigned international numbers. Some of these cultures have completed more than 300 generations and no change in their pathogenicity has been observed.

Amongst these race 21, 40, 42 of black rust, races 10, 20 and 63 of brown rust and 19 and 31 of yellow rust have been met with quite frequently. It is, however, interesting to note that race 15 of black rust which was a common race, some years back, is not frequently met with now whereas race 21, a rare race before 1942, has come to occupy a prominent position. Information available on the factors responsible for the predominance of certain races is however very meagre. The climatic condition prevailing in a particular region of the country as also the varietal position would play an important role in the persistence of particular race. With the introduction of new and improved wheats some of the unimportant races as also others so far undiscovered may come into prominence and this aspect requires very careful consideration.

In view of the fact that source of annual recurrence of these rusts lie in the hills it was suggested that epidemics could be controlled to a large extent by the elimination of inoculum from pockets of oversummering, by the destruction of volunteer plants, suspension of summer crop in Nilgiri and Palni Hills, by replacement of wheat and barleys by oats or by cultivation of rust resistant varieties at such altitudes. Due to the possibility of oversummering in the Western Ghats as also in the absence of knowledge regarding the collateral hosts, the suspension of wheat cultivation in Nilgiri and Palni Hills does not appear to be a practical proposition. Also destruction of volunteer plants in the inaccessible areas in the hills is fraught with difficulties and does not appear to be practicable.

Undoubtedly the most effective method of control is the cultivation of resistant varieties. The work of breeding resistant varieties on all India basis is in progress at the Indian Agricultural Research Institute as also in the States. Since all the indigenous varieties tested were found to be susceptible to Indian races, it was considered necessary to cross them with foreign resistant varieties. Some Kenya Wheats which have shown marked resistance to the Indian races of black rust have been used as parents along with N. P. 165 and N. P. 120. Selections from these crosses have proved to be resistant and are under trials in different parts of the country. For brown rust resistance some foreign wheats like Mediterranean and Democrat have been crossed with N. P. 114, and Pb. C. 518 respectively in an attempt to combine their resistant character with other good agronomical characters. Spaldings prolific and Carsten V, two of the differential hosts of yellow rust have been crossed with improved Indian varieties.

Side by side attempts are being made to produce a variety resistant to all the three rusts and for that Spaldings prolific and Democrat wheats were crossed with N. P. 114 and Pb. 518 respectively and their progenies (in F. 8 generation) crossed together and the hybrid so obtained crossed with Kenya wheat to introduce the resistance for black rust. Promising results for the production of resistant types to individual rusts have been obtained but intensive research for the production of material resistant to all the three rusts is necessary.

I have indicated briefly the lines of work that are in progress in different parts of the country and also the lines in which future work is to be directed. The subject has gained greater importance since the partition of the country resulting in the loss of important wheat producing belt and the proper study of these problems requires teamwork by Plant Pathologists, Geneticists and Plant Breeders to combat serious losses for which wheat rusts are responsible.

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SEVENTH ANNUAL REPORT OF THE INDIAN PHYTOPATHOLOGICAL SOCIETY (1953)

I am presenting herewith the Seventh Annual Report for the year 1953 of the Indian Phytopathological Society. During this year twelve new members were admitted to the Society bringing the total number to 180. A large number of members has not yet paid the 1953 membership fee but it is expected that it would be paid soon. The total number of subscribers at present is 130. I am very happy to state that our Journal now enjoys a wide circulation in America, Europe, Asia and Australia, and practically every big library is subscribing to it. Subscriptions from India, however, continue to be few in number and it is requested that individual members would exercise their influence to secure more subscribers and also enrol more members.

Two numbers of Indian Phytopathology were sent out during this year and third number would be issued by the middle of this month. This would be Vol. V, No. 2 of 1952. That means that we are still in arrears by one year. Every effort will be made to make it up during 1954 provided the members cooperate by sending their scientific papers to us in preference to foreign journals. Considering the wide circulation which Indian Phytopathology now enjoys, it should no longer be necessary to send these papers for publication abroad.

It is a matter of great satisfaction that the financial position of the Society continues to be sound. The year started with an opening balance of Rs. 5,251-8-9 putting aside a sum of Rs. 5,000/- invested in National Savings Certificates. Income during the year amounted to a round figure of Rs. 3,000/- and the amount spent was about Rs. 2,600/- A sum of Rs. 500/- was received as publication grant from the National Institute of Sciences of India for which we are very grateful. The Indian Council of Agricultural Research have discontinued their subsidy towards the publication of this Journal because, according to them, no help is required by us on account of our sound financial position. A duly audited Statement of Receipts and Expenditure for the previous year is placed before you and that for 1953 will be sent to you after it has been audited.

As decided in the Annual General Meeting held last year, a circular was sent to all the members inviting their views and suggestions for the commemoration of the services of late Dr. B. B. Mundkur towards Mycology in India. The response unfortunately was poor.

I take this opportunity to express my grateful thanks to the members of the Society, the President and the Councillors for their kind support in the discharge of my duties. I am particularly grateful to my friend Dr. S. P. Raychaudhuri for helping me in various ways.

R. Prasada
Secretary-Treasurer

2. 1. 1954

Minutes of the Seventh Annual General Meeting held on 3-1-1954 at the Indian Science Congress Session at Hyderabad-Dn.

In the absence of the President of the Society, Rev. H. Santapau was unanimously elected to preside over the meeting which was attended by nine members and three visitors.

The minutes of the Sixth Annual General Meeting were read and confirmed.

Report for 1953 was presented by the Secretary-Treasurer.

The ballot papers were opened and scrutinised by the Chairman and the Secretary-Treasurer and the following members were declared to the Council of 1954 :—

President	...	...	Dr. S. N. Das Gupta.
Vice-President	...	...	Dr. P. R. Mehta.
Councillors	...	...	Dr. M. R. S. Iyengar.
			Dr. R. S. Mathur
			Dr. U. N. Mohanty.
			Shri K. G. Nema.
			Dr. N. Prasad.
			Shri K. V. Srinivasan.

The Following resolutions were passed unanimously :—

1. Resolved that a sum of Rs. 29-6-6 (Rupees Twenty nine, annas six and pies six only) which remained unaccounted for on account of the sudden death of Dr. B. B. Mundkur in December, 1952, be written off as irrecoverable.

2. Resolved that a part-time clerical aid be allowed to the Secretary-Treasurer upto Rs. 30/- per month for office and editorial work.

3. Resolved that the Secretary-Treasurer should attend the Annual Meetings of the Society and draw single II Class railway fare and Rs. 40/- (approximately 4 daily allowaces) to cover part of incidental expenses, in case he is not sent officially as a delegate from his Institution.

4. Resolved that the Editor-in-Chief should be an ex-officio member of the Council.

In the absence of the retiring President, Dr. R. S. Vasudeva, copies of his address were distributed to the members present.

The meeting terminated after passing votes of thanks to the retiring office-bearers, the National Institute of Sciences of India for their generous financial aid, the Indian Science Congress Association for providing necessary facilities and the Chiarman for conducting the proceedings of the meeting.

R. Prasada
Secretary-Treasurer

H. Santapau
Chairman

INDIAN PHYTOPATHOLOGICAL SOCIETY

Instructions to Authors

Membership in the INDIAN PHYTOPATHOLOGICAL SOCIETY is pre-requisite to publishing in INDIAN PHYTOPATHOLOGY but the Editorial Board may relax this rule in the case of contributions of exceptional merit and communicated with a special recommendation by a member. The Editorial Board may invite distinguished scientists to contribute articles of interest to the Society.

Contributions should be on one side of the page, double spaced, with a 1-1/4th inch margin on the left. In form and style, such as punctuation, spelling and use of italics, the manuscript should conform to the best Journals in the U.K. and U.S.A. Authors should strive for a clear and concise style of writing. The name and address of the Institution at which the work was done should be cited immediately after the SUMMARY at the end of the article on left hand side. Tables should be numbered and each table should have a heading stating briefly its contents. References to literature should be made as foot notes *only* when four or fewer citations are given. If there are more, they should be listed under 'REFERENCES' at the end of the paper and referred to by date in brackets in the body of the article. Citation should give the name of the author (or others), his (or their) initials year of publication and then the full title correctly, followed by the name of the Journals, number of the volume, a colon and page numbers. If the title is in a foreign language, then diacretic signs and capitalization should be precisely as in the original. The names of the Journal should be as abbreviated in the WORLD LIST OF PERIODICALS, 2nd Ed., 1934, but as that book may not be available to all, contributors are requested to give the titles in full. Abbreviating will in that case, be done by the Editors. If an article has not been seen in original, then that fact should be clearly stated. An example citing is given below :—

Conovor. R.A. (1948)......Studies of two viruses causing mosaic diseases of soybean. *Phytopathology*, **38** : 724-735.

Because of high cost of half-tone blocks carefully made line drawing on Bristol board in black ink will be preferred. Photographs when necessary should be printed on glossy contrast paper and be of best quality. Full page figures and photographs should be made to reduce $4 \times 6\frac{1}{2}$ inches, the standard size for all plates. Each author is allowed one page of half-tone illustration for each article or its equivalent, and the cost of half-tone blocks and paper in excess will be charged to author. Drawings must be drawn to standard scales, so that they can be compared with one another. *e.g.*, $\times 10$, $\times 50$, $\times 100$, $\times 250$, $\times 500$ etc. It is not always possible to get a magnification at a round figure with a camera lucida but the printer can readily reduce drawings at any magnification to the standard, provided a scale is added to the drawing. The scale should measure from 5 to 10 cm. the longer the better and the printer should be instructed to reduce this line to the desired magnification.

Authors are invited to consult Bisby's 'An Introduction to Taxonomy and Nomenclature of Fungi' (1945), pp. 38-41 and Riker's 'The preparation of manuscripts for *Phytopathology*, *Phytopathology* **36** : 953-977, 1946, before preparing their mss. and figures.

Articles will be published in the order of their approval for publication but the address of the retiring President and invitation articles will be published when received.

To comply with the International Rules of Botanical Nomenclature, Latin descriptions must be supplied to validate new species and genera.

Authors requiring reprints with or without covers should place an order for the copies wanted at the time of returning the proofs and they will be charged actual cost.

INDIAN PHYTOPATHOLOGICAL SOCIETY

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